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Auglaize River Power Development

HYDRO-ELECTRIC PLANTS WHICH EVENTUALLY WILL GIVE THE NORTHWESTERN CORNER OF OHIO AN UNFAILING SUPPLY OF POWER

LITTLE MORE THAN a year ago the world was reading with horror the reports of the disastrous floods which covered miles and miles of territory in the states of Ohio and Indiana. From many quarters came suggestions as to how such a catastrophe could be averted in the future, the most common, no doubt, was to build dams and make storage reservoirs for hydro-electric plants. Little did the people who made these suggestions know the extent to which this very thing had been done and how these reservoirs were as a mere drop in a bucket compared with the deluge which affected a great share of the State of Ohio. It will, no doubt, be interesting to study for a time one of those hydro-electric developments which was in the heart of the flooded district, for it will prove that the industrious people of Ohio are fully awake to the possibilities of the water power which formerly went to waste.

Near St. Marys, are 2 reservoirs, the Grand, covering an area of 16,000 acres, and the Loramie, with an area of 3000 acres, which were made by the state to feed the

FIG. 4. VIEW IN GENERATOR ROOM OF DEFIANCE PLANT

Miami & Erie Canal, formerly extensively used for transportation purposes.

Through the efforts of the Auglaize Power Co., the surplus from these reservoirs is leased and fed to the Auglaize River. Near Defiance, a concrete dam was swung across the Auglaize River, making another reservoir about 18 mi. long and with an average depth of 10 ft., covering an area of 4000 acres. This is about 45 mi. down stream from the State Reservoirs, and it is at this place that there is located the principal hydraulic plant of the Auglaize system. The tail waters from here follow the bed of the river, but in case they are needed may be diverted at Grand Rapids to the Miami & Erie Canal, which is the source of water for another hydroelectric plant at Maumee, this canal being leased from the state.

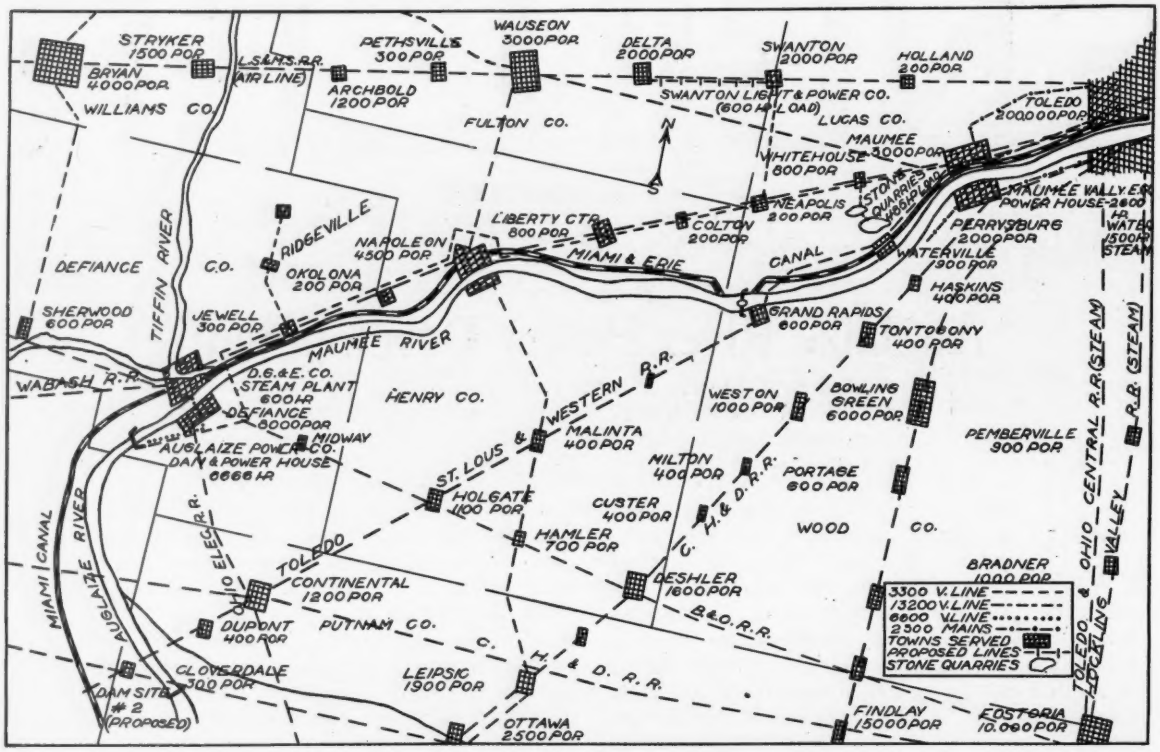


FIG. 1. TERRITORY SERVED BY AUGLAIZE DEVELOPMENT

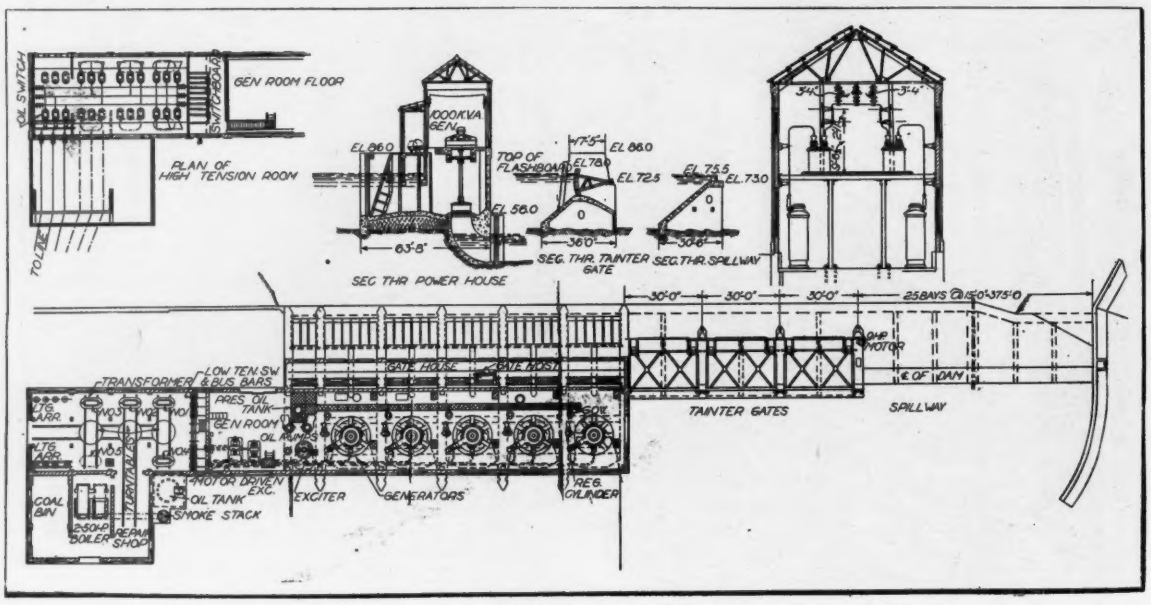


FIG. 2. PLAN AND CROSS SECTION OF DEFIANCE PLANT AND DAM

Territory Served

These plants are operated in parallel, being connected by a high-tension transmission line and are owned by H. L. Crawford & Co., but operated under the names of the Auglaize Power Co. and the Maumee Valley Electric Co.

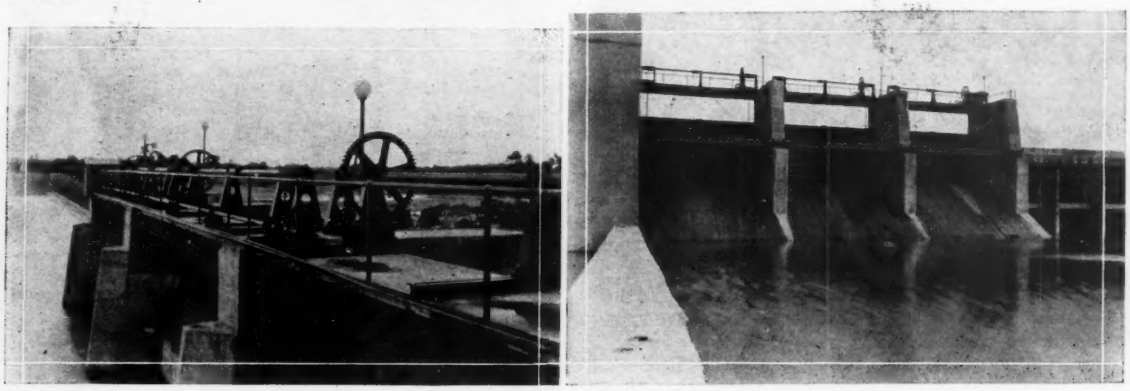


FIG. 3. A. VIEW OF TAINTER GATES FROM ABOVE B. VIEW OF TAINTER GATES FROM BELOW

These plants deliver current to distributing stations which furnish power and light to Defiance, Jewell, Okolona, Swanton, Liberty Center, White House, Maumee, Perrysburg, outskirts of Toledo and the Toledo Railways & Light Co.; while lines are being extended to other towns as fast as the demand for service is made. The line is now operated at 33,000 v., 25 cycles, but when the load increases the voltage will be raised to 60,000; a short line, however, from the generating station to Defiance is operated at 6600 v., 25 cycles. At Defiance, and at Maumee, are steam plants which tie in with the hydro system and frequency changers are located at these points to give 60 cycles for lighting purposes. The Maumee plant is the distributing station for Toledo and vicinity, while other towns along the line are provided with transformer stations only.

Dam at Defiance

As previously stated, the principal hydraulic power plant of the system is located a few miles southwest of Defiance, where the dam is placed across the river, giving a normal head upon the water turbines of 23 ft.

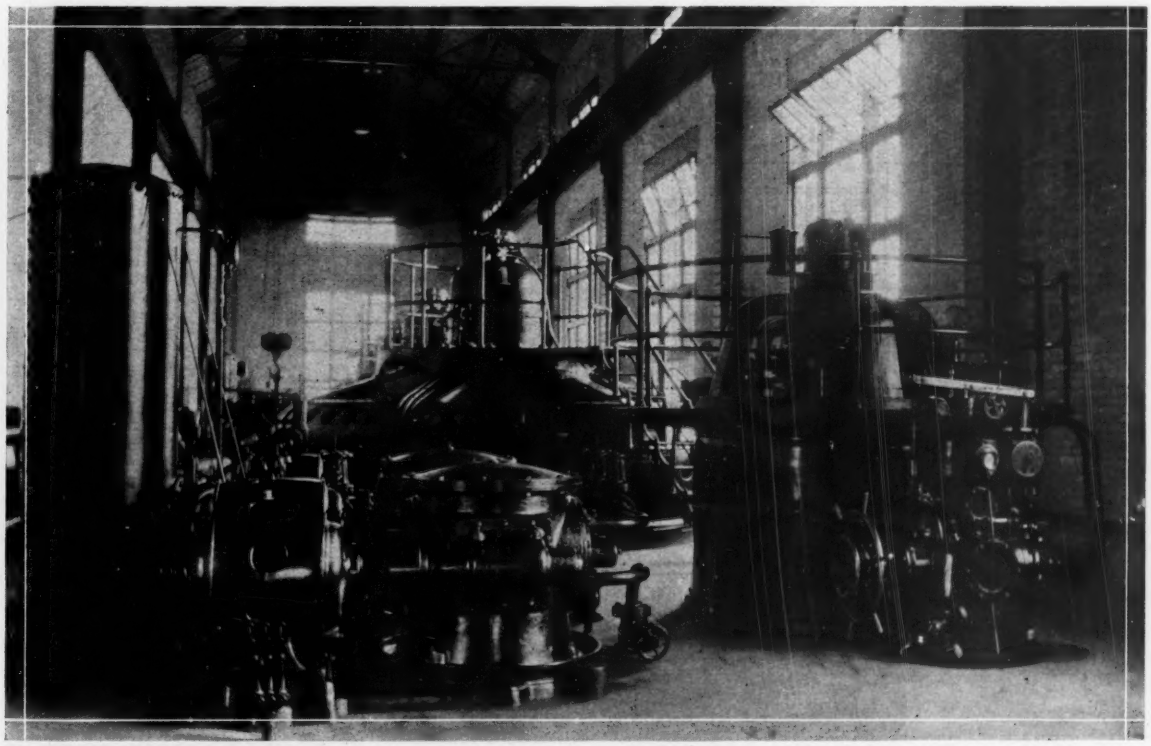


FIG. 5. OIL PUMPS AND HYDRAULIC-DRIVEN EXCITER; DEFIANCE STATION

The spillway consists of 25 bays of reinforced concrete each 15 ft. long, making a total length of 375 ft. There are 3 Tainter gates adjoining the power plant, each 30 ft. long, which are operated through bevel gears and clutches from a line shaft driven by a 9-hp. back geared and closed by a motor-driven traveling hoist. For convenience in cleaning the trash racks a mono rail is attached to the outside wall, from which is suspended a traveling chain hoist used to raise the baskets of trash as they are filled.

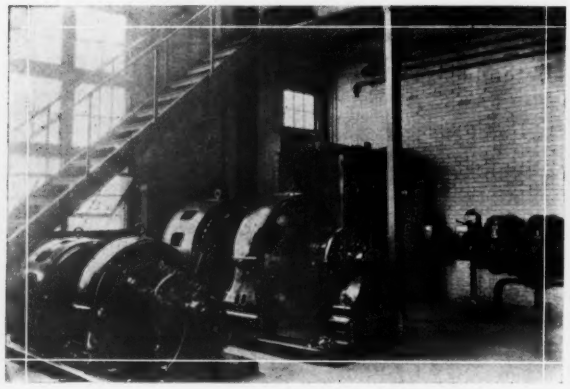


FIG. 6. MOTOR-DRIVEN EXCITERS

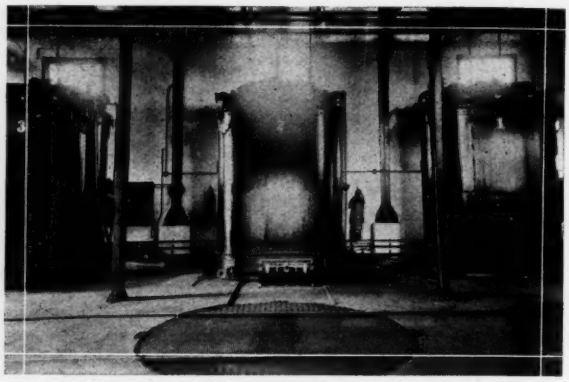


FIG. 8. VIEW IN TRANSFORMER ROOM

motor, this being plainly shown in Fig. 3. Cross sections of the dam can be seen in the general plan of the plant. Steel plates are used in the construction of these gates, which are made up into the arc of a circle and swing on pivots firmly attached to the masonry.

Water is taken to the turbines through trash racks and lift gates, as shown in the plan. The gates, 2 to each main turbine and one to the exciter, have an opening of 9 ft. by 12 ft. 10 in. each, and are all opened

The course of the water through the turbine and draft tube is clearly indicated in the cross section. All of the concrete construction work was done by the Ambursen Hydraulic Construction Co., of Boston.

Hydraulic Generators

In this plant are 5 Allis-Chalmers hydraulic turbo generators, each rated at 1000 kv.a., generating current at 2300 v. 3-phase, 25 cycles, and run at 94 r.p.m. All

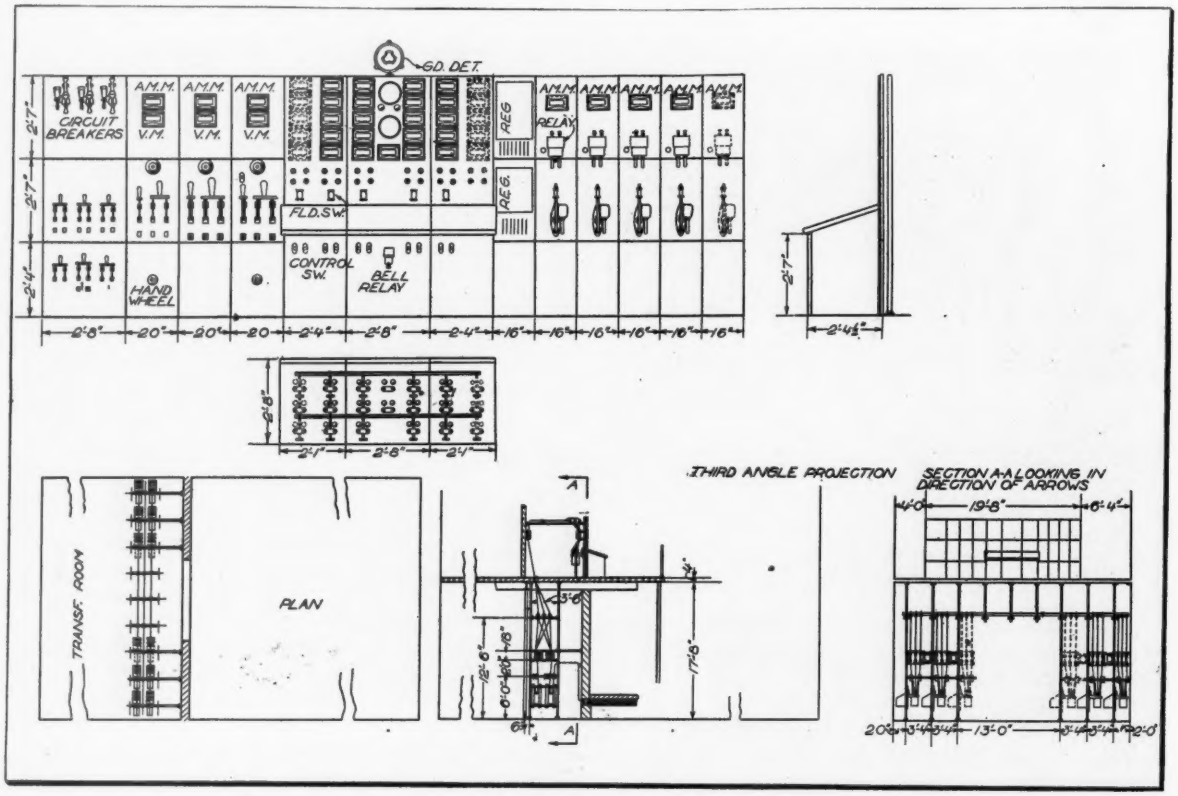


FIG. 7. ARRANGEMENT OF SWITCHBOARD APPARATUS AND 2300-V. REMOTE CONTROL SWITCHES

are of the vertical type, with the main supporting bearing at the top, guide bearings being placed between the generator field and the turbine rotor, and at the bottom end of the shaft. The bearings above water are supplied with oil under pressure, while those under water are fed grease by means of a hand operated grease pump.

FIG. 9. HIGH TENSION REMOTE CONTROL CIRCUIT BREAKERS

The turbines are of the Francis type and the speed is closely regulated by means of an oil operating governor; i. e., oil at 150 lb. pressure operates the opening and closing of the turbine gates under the control of the governor. The turbines may also be controlled from the switchboard by means of motors. Excitation for these generators is furnished by 3 units, 1 turbo-generator rated at 1000 amp., 125 v., running at 240 r.p.m., and the other 2 are driven by 2300-v. motors, one rated at 600 amp., running at 720 r.p.m., the other 1000 amp., at 480 r.p.m.

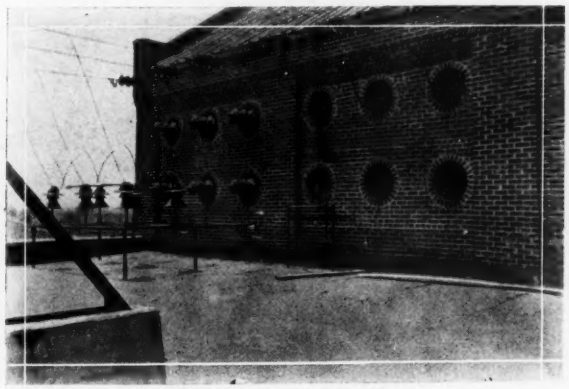


FIG. 10. METHOD OF CARRYING HIGH TENSION WIRES THROUGH POWER HOUSE WALLS

Oil for the governors is pumped by 2 motor-driven rotary pumps, the motors being 40 hp. each running on current at 220 volts, 3-phase.

Water for cooling bearings and transformers is pumped by 2 Goulds triplex pumps, each driven by 5-hp. motors.

To facilitate the handling of machinery a 60-ton traveling crane is provided. This was built by the Northern Engineering Co., of Detroit, and is equipped with electric hoist, but otherwise hand operated.

Cables and Switchboard

All cables from generators and exciters are cambric insulated, lead covered and run in conduits. Generator cables lead to remote control switches in the transformer room to the transformers; exciter and all direct-current cables run direct to the switchboard.

All switchboards and switching apparatus were furnished by the General Electric Co. and are of standard types. The switchboard is in a gallery at the south end of the generator room, separated by a wall from the high-tension switching compartment, and consists of 11 panels and 2 bench panels. The benchboard controls the solenoid switches, motor operated rheostats and governor motors. Of the vertical board, 1 panel is for the control

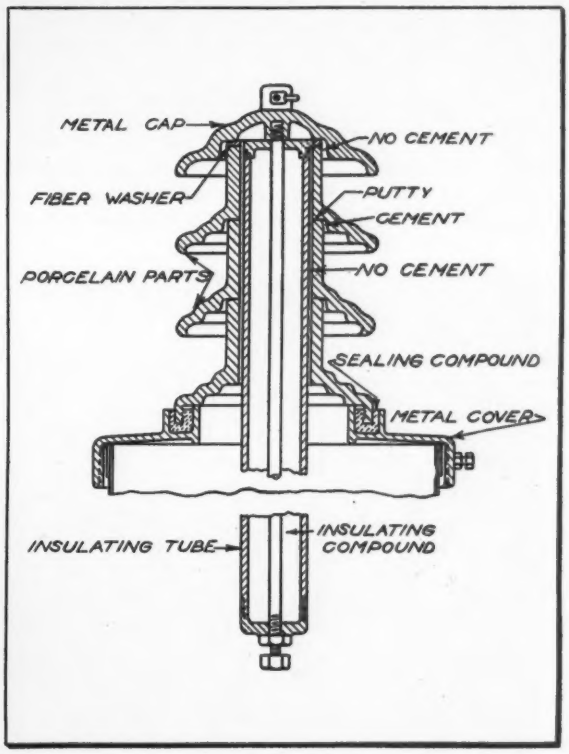


FIG. 11. DETAILS OF LIGHTNING ARRESTER ENTRANCE BUSHING

of the d. c. motors, 3 panels for the exciters, 3 generator panels, one for the Tirrill regulator, and 3 panels for the a. c. power circuits, which operate the exciter motors, etc. The usual equipment of instruments is mounted upon the switchboard and on the back are 5 recording wattmeters, one for each main generator.

Voltage Boosters

The transformer room is on the main floor and is so equipped with tracks and turntables that any of the transformers may readily be disconnected and wheeled to the repair room in case of necessity. The principal transformers are 5 1000-kv.a., 3-phase, connected in delta with a ratio of transformation of 2300 to 60,000,

but at present the high voltage is 33,000. They were manufactured by the General Electric Co. and are used on the Toledo division.

Three single-phase Allis-Chalmers transformers, each of 400 kv.a. capacity, with a transformation ratio of 2300 to 6600 volts, feed the line to Defiance, while 3 Allis-Chalmers 25-kv.a., single-phase transformers with a ratio of 2200 to 220-110 are used for station lighting.

The oil tanks for the electrolytic lightning arresters are also located in the transformer room; the horn gaps for the 60,000-v. line are outdoors, while the gaps for the 6600-v. line are in the high-tension switching room just above the transformers.

All the main transformers are oil and water cooled, water being furnished by pumps in the generator room, as previously stated.

Provision is made for draining the oil to a reservoir, in case it is found necessary, by means of pipes with hose connections. The plant is also equipped with a General Electric transformer oil drying and filtering outfit.

H. T. Switches and Transmission Line

In the high-tension switch room, a view of which is shown in Fig. 9, are 6 60,000-v. remote control circuit breakers, one for each transformer and one for the outgoing line. There is also a circuit breaker for the

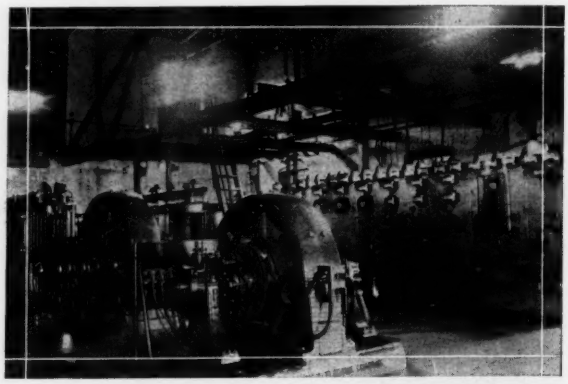


FIG. 13. ROTARY CONVERTERS AND MAIN SWITCHBOARD AT MAUMEE

The transmission line is constructed of steel A frame and strain towers, flexibly built, with a steel strain cable attached to the tops of the towers. The minimum height of the lowest wire is 29 ft. 8 in., but is increased to 54

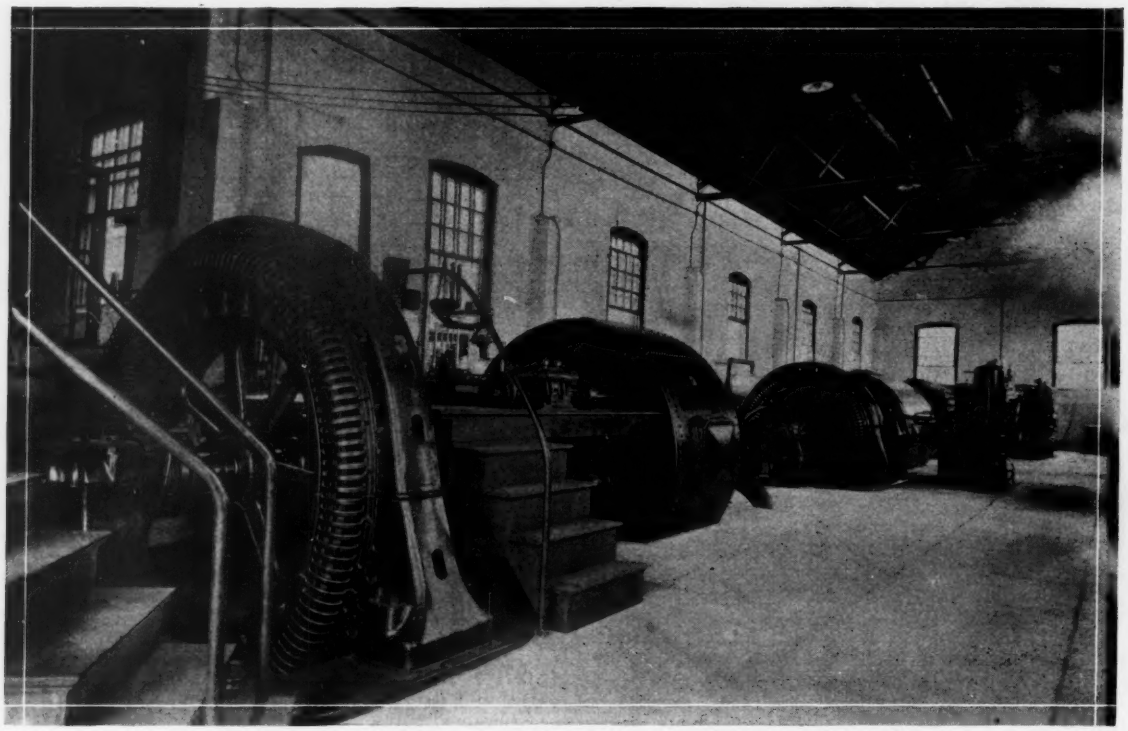


FIG. 12. VIEW OF GENERATORS IN MAUMEE PLANT

6600-v. line to Defiance. Figure 10 shows the method of taking the high-tension lines through the power house wall to the transmission line.

Heat during winter is supplied by 2 Erie City return-tubular boilers, of 50 hp. each, which are run at a pressure of 10 to 15 lb., this being reduced by reducing valves to suit requirements in the plant and dwellings near by.

ft. in the towns. The towers have a spacing of about 400 ft. On the cross arms are suspension type insulators, which support the hard drawn copper stranded cables. This transmission equipment is the product of Archbold Brady Co., Syracuse, N. Y.

The Maumee Plant

At the Maumee plant are 3 hydraulic turbo generators which get their supply of water from the Miami & Erie canal through steel tubes at a head of 62½ ft. with the tail waters going direct to the Maumee River.

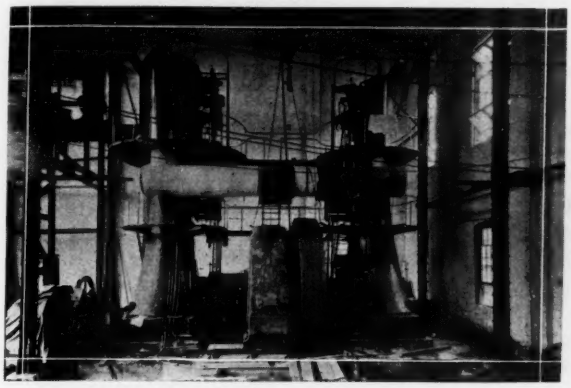


FIG. 15. ALLIS-CHALMERS-WESTINGHOUSE UNIT DURING ERECTION; MAUMEE PLANT

These units are all of the horizontal Francis type built by the Allis-Chalmers Co. Nos. 1 and 2 are rated at 750 kw., 2300 v., 3-phase, 60 cycles, 450 r.p.m., with direct-connected exciters. No. 3 has a capacity of 450 kv.a., 2300 v., 3-phase, 60 cycles, running at 240 r.p.m.

In addition to the hydraulic equipment, the plant is being enlarged to provide against any shortage of water, which may be due to the canal freezing, by the addition of 2 1000-kv.a., cross compound, vertical Allis-Chalmers-Westinghouse direct-connected Corliss engine units. These will be supplied with steam by 4 Heine water-tube boilers.

One of these engines and 2 boilers are nearly ready for operation, as will be seen by the photographs, Figs. 15 and 16. The dimensions of the engines are 28 and 56 by 48 in., and the generators are rated at 400 v., 1484 amp., 3-phase, 94 r.p.m. A Worthington barometric condenser will serve these units.

FIG. 16. HEINE BOILERS DURING ERECTION AT MAUMEE

As previously stated, the Maumee plant is the distributing station for Toledo and vicinity and works in parallel with the Defiance plant. The frequency of alternations of the generators, however, is not the same as that of the high tension line, so the use of a General Electric frequency changer is resorted to; this consists of a synchronous motor of 1420 hp. capacity run on

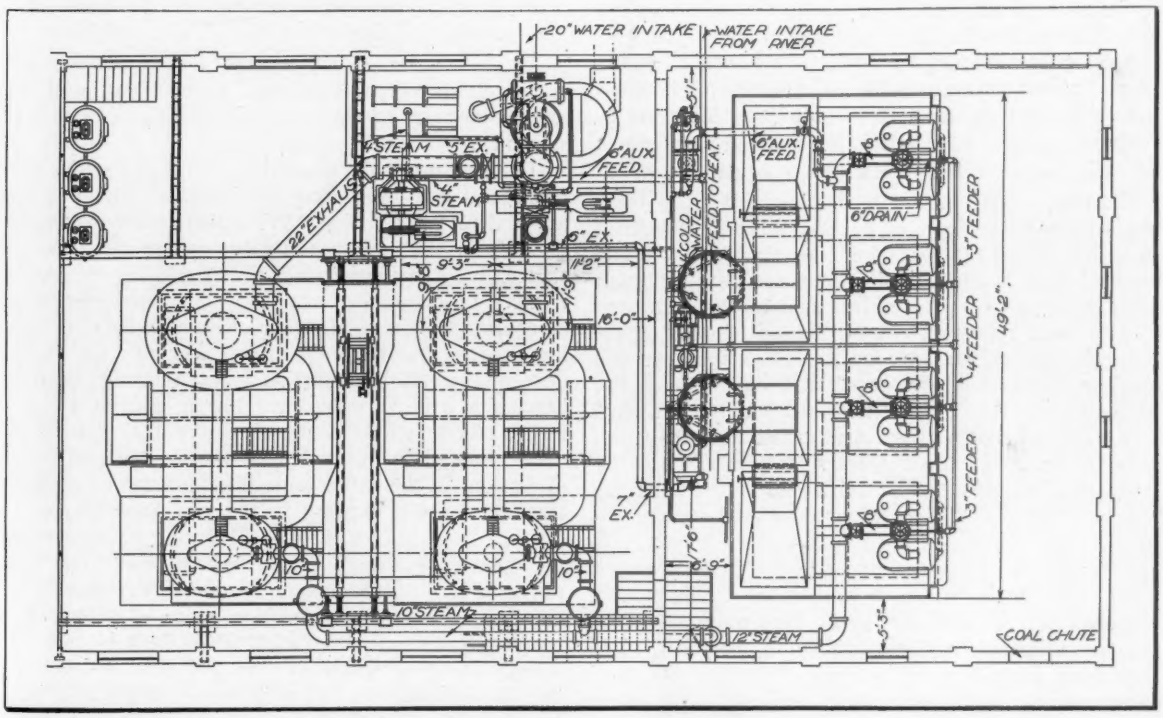


FIG. 14. PLAN OF MAUMEE STEAM PLANT

2300 v., 25 cycles, direct-connected to an a. c. generator rated at 1000 kw., 2300 v., 60 cycles.

Other equipment of this plant consists of the necessary transformers, rotary converters, which supply direct current for the railways, arc light generators, lightning arresters and necessary switching facilities.

This complete hydraulic system has been in operation for nearly 2 yr., and has worked without failure except during the flood of last year, a circumstance which could not be foreseen and which is likely never to happen again. The reservoir capacity available for these plants is estimated to be sufficient to operate them for 90 days of 24 hr., at full capacity, without rain.

For courtesies extended during the preparation of this article and information in regard to the operation of the system, we are indebted to the Auglaize Power Co., and particularly to W. P. Wallace, the general manager.

Some Power Transmission Economics

BEARINGS. BY REGINALD TRAUTSCHOLD

FOR the support of shafting, bearings of some description—either pillow blocks or hangers—are required, the cost of which varies with the diameter of the shaft, increasing the economic value of the light high-speed shaft, but greatly complicating the economic choice of equipment, owing to the multiplicity of bearings that may be used and the great variation in their economic value. The bearings may be of the rigid, the adjustable or the ball and socket type, and may be simply babbited, or equipped with rings or chains for distributing the lubricant over the bearing surface, or they may be of the roller or ball bearing construction. All of these varieties of bearings possess different economic value in their consumption of power through friction, etc. For line shaft service, pillow blocks are usually of the rigid type of construction; while the hangers are of the adjustable construction so as readily to adjust themselves to the alinement of the shaft, accurate alinement being more difficult in the case of hangers or floor-stands than in the case of pillow blocks.

Considering pillow blocks first, the available blocks may be grouped as plain, wick oiling, ring or chain oiling and roller bearing, for rigid pillow blocks; and as plain, ring or chain oiling and roller bearing for the ball and socket and adjustable construction of bearing. These 7 distinct standard types of pillow blocks are of varying economy, as far as friction losses are concerned, and each type of block varies in comparative cost.

The comparative cost of these various types of bearings is graphically depicted on Chart III*, the base of comparison being the cost of a 1-in. rigid pillow block, plain babbited bearing, or 4.5 times the base that was used for the comparative cost of shafting. These comparative costs represent simply the initial cost of the pillow blocks and in no way indicate their "proportional cost" or the economic value of such equipment. The various types of bearings all have different coefficients of friction and the loss from such causes fixes the "proportional cost" of the respective bearings. For instance, of 2 bearings of equal initial cost, but one having twice as great a coefficient of friction as the other, the bearing with the lesser frictional loss would be but ½ as expensive proportionally as the other; i.e., its "proportional cost" would be but ½ that of the other bearing, although their comparative costs were the same. The economic value of the 2 bearings would differ still more, depending upon the actual cost of power; but such refinement of comparison, though necessary for ascertaining the "true" economic value of any bearing, has no effect upon the "relative" economic value of the bearing and furthermore complicates the question of pillow block economics to such an extent as to prohibit such investigation in a discussion of this character. The proportional cost of the respective bearings, measuring what is actually obtained for a given outlay, represents what may be termed the relative economy of the various types of bearings. Taking the relative economy of a pillow block with a plain babbited bearing as unity, the average relative economy of other standard types of bearings suitable for line shaft service is given in Table I. The comparative costs of bearings, as given on Charts III and V, divided by the values given in this table, give the proportional costs of the various bearings —see Example 2.

TABLE I

RELATIVE ECONOMY OF BEARINGS

AVERAGE VALUES

Plain babbited bearing	1.000
Wick oiled bearing	1.036
Ring or chain oiled bearing	1.366
Roller bearing	3.750

EXAMPLE 2

Required comparative cost, proportional cost and relative economy of various standard 3 15/16-in., 3 3/16-in., and 2¾-in. rigid pillow blocks.

Comparison of the proportional cost of various bearings shows some interesting peculiarities. This is graphically depicted on Chart IV, which clearly illustrates some facts that are not usually recognized. For instance, rigid roller-bearing pillow blocks are not as relatively economical, as far as proportional cost is concerned, as a plain rigid pillow block with babbited bearing in sizes less than 1½ in. in diameter and do not develop their full proportional cost economy until the bearing is 2 in. in diameter. The proportional cost of larger blocks is only about 80 per cent of that of corresponding plain pillow blocks, the sudden and violent alterations in the curve being due to matters pertaining to constructional expense in the manufacturing of the blocks. Rigid pillow blocks of the ring oiling type are much less economical in proportional cost than plain pillow blocks of the smaller sizes and are but 15 per cent more costly for sizes from 2 in. up. The roller-bearing type of universal adjustable pillow block is very economical in proportional cost for bearings less than 3¾ in. in diameter, but such size of adjustable roller-bearing pillow block is less economical than a similar plain babbited bearing.

*See Practical Reference Tables for Charts III, IV and V.

These vagaries in the proportional cost of bearings simply emphasize the necessity of studying each individual installation to ascertain the advisable block to use. In one case, a certain type of bearing might prove most economical and in another, not at all economical. In the case of 3-in. bearings (see Example 3), the roller-bearing construction would be the most economical, whether rigid or adjustable pillow blocks were employed, with what may be termed the relative cost in favor of the rigid bearing of about 28 per cent. In order of relative economy in first cost would then come the various types of rigid pillow blocks and the most expensive bearing would be of the ball and socket construction, the relative proportional cost of such bearings constructed for ring or chain oiling and the plain babbited type of

Type of Pillow Block (rigid)	Size	Comparative Cost	Proportional Cost	Relative Economy
Plain bearing	3 15/16"	11.50	11.50 / 1.000 = 11.5	107.5
Wick oiled bearing		12.60	12.60 / 1.036 = 12.2	114.0
Ring oiled bearing		23.80	23.80 / 1.366 = 17.4	162.6
Roller bearing		40.33	40.33 / 3.750 = 10.7	100.0
Plain bearing	3 3/16"	6.85	6.85 / 1.000 = 6.85	116.3
Wick oiled bearing		7.65	7.65 / 1.036 = 7.38	135.3
Ring oiled bearing		12.90	12.90 / 1.366 = 9.44	160.3
Roller bearing		22.10	22.10 / 3.750 = 5.89	100.0
Plain bearing	2¾"	4.40	4.40 / 1.000 = 4.40	121.2
Wick oiled bearing		4.90	4.90 / 1.036 = 4.73	130.3
Ring oiled bearing		8.20	8.20 / 1.366 = 6.03	166.1
Roller bearing		13.60	13.60 / 3.750 = 3.63	100.0

such pillow block being nearly the same. A similar comparison of the proportional cost of other sizes of pillow blocks may show quite a different order of relative value in initial cost, so that where one type of bearing of given diameter might prove satisfactory, it does not follow that the same type of bearing of other diameter would rank correspondingly high in comparative economy.

Example 3

Required the relative proportional costs of 3-in. standard pillow blocks.

A comparison of drop hangers, or floor-stands, shows even more variations than was shown in the case of pillow block bearings. Two conditions here affect the cost of equipment, the diameter of the bearing and the drop of the hanger. Chart V depicts the comparative cost of various standard hangers with the minimum customary drop and also shows the comparative increase in the cost of hangers of greater drop, the base of comparison being the cost of a 1-in. bearing hanger of 8-in. drop, plain babbited, which is taken as unity. The increase in cost of deeper hangers—greater drop—follows no apparent rule, but is governed by production or manufacturing expenses, which tend still further to complicate the economical choice of drop hangers. Example 4 deals with hangers of different diameter bearing and varying drop and, though in each case the roller bearing hanger is the most economical in proportional cost and

Type of Pillow Block	Proportional Cost Comparative	Relative
Rigid Construction		
Plain bearing	100.0	147.0
Wick oiled bearing	104.0	153.0
Ring oiled bearing	110.5	162.5
Roller bearing	68.0	100.0
Ball and Socket Construction		
Plain bearing	100.0x1.6=160.00	235.0
Ring oiled bearing	99.5x1.6=159.25	234.0
Roller bearing (adj.)	54.5x1.6= 87.20	128.0

the adjustable hanger with a plain babbited bearing is the least economical in the case of the hanger with the greatest drop, and the wick oiled bearings the highest in proportional cost for the hangers with lesser drop, there is considerable variation in the extreme relative costs of hangers for each size of bearing—the relative cost ratios being 100:218.5, 100:190.5, and 100:194.0 for the 3 15/16-in., 3 3/16-in., and 2¾-in. bearings respectively.

Example 4

Required relative cost of various standard drop hanger bearings—3 15/16 by 32 in., 3 3/16 by 16 in., and 2¾ by 12 in.

The results arrived at in Example 4 again emphasize the necessity of individual consideration in the selection of bearings and indicate economic blunders that may result from lack of such attention. The plain babbited bearing is naturally the cheapest in first cost, but also is the most expensive, or next to the most costly, in

Type of Hanger Adjustable	Size	Drop	Comparative Cost	Proportional Cost	Relative Cost
Plain bearing	3 15/16	32	6.75+4.54	11.29/1.000=11.29	218.5
Ring oiled bearing			8.60+4.54	13.14/1.366= 9.62	186.4
Roller bearing			14.80+4.54	19.34/3.750= 5.16	100.0
Plain bearing	3 3/16	16	4.20+0.91	5.11/1.000= 5.11	181.5
Wick oiled bearing			4.65+0.91	5.56/1.036= 5.36	190.5
Ring oiled bearing			5.40+0.91	6.31/1.366= 4.62	164.0
Roller bearing			9.65+0.91	10.56/3.750= 2.82	100.0
Plain bearing	2¾	12	2.85+0.26	3.11/1.000= 3.11	183.0
Wick oiled bearing			3.15+0.26	3.41/1.036= 3.29	194.0
Ring oiled bearing			3.65+0.26	3.91/1.366= 2.86	168.2
Roller bearing			6.10+0.26	6.36/3.750= 1.70	100.0

proportional cost; its relative cost is invariably high. The difference in economic value of various bearings of the same dimensions, in the particular instances considered, is clearly apparent when the economic waste is expressed in terms of concrete value. For instance, the difference in proportional cost between the most costly and the least expensive, 3 15/16 by 32-in. hanger would be equivalent to the cost of nearly 1¾ ft. of high-grade, 3 15/16-in. shafting. The 2 smaller hangers would not entail proportional losses, it is true, but the economic loss due to poor choice of bearing would still be considerable and profitably avoided.

Regulation of Air Compressors

Brief Discussion of Principles Involved in Several Methods of Capacity Regulation of Large Constant Speed 2-Stage Compressors. By H. L. Dean

MUCH has been written about the advantages of 2 or 3-stage compression, of the economy attending steam compounding and of the vast superiority of the duplex over the straight line design; but, while steam-driven compressors, as typified by the cross-compound Corliss type, reflect the highest engineering knowledge and skill, it is a fact, only too well appreciated by compressed air engineers, that the development of a simple, efficient and theoretically and practically correct capacity control for large constant speed units has been in the main sadly neglected.

That this statement is irrevocably true, is evidenced by the fact that since the inception of large central stations for the generation of electricity and the resulting replacement of the most economical steam compressors by motor-driven units, practically all of the new business has been concentrated in the hands of those few manufacturers who have perfected a true variable or 4-step capacity regulator.

Let us summarize the conditions and functions which an ideal regulator of a 2-stage machine must fulfill, after which we will describe and discuss the types of controls and unloaders commonly applied.

1. Variable delivery requirements within the maximum capacity of the compressor must be promptly met without abrupt load changes and their resulting shocks and strains.

2. A constant cylinder ratio should be preserved at all loads in order to retain the benefits of 2-stage compression and to avoid excessive heating.

3. Compressed air should not be discharged to the atmosphere.

4. Power consumption should be practically proportional to air requirements.

5. When entirely unloaded, the compressor should run free of all load except friction.

6. The controlling equipment should be as simple as possible, avoiding auxiliaries.

Probably the most common method of regulating capacity is by throttling or choking the intake air; but controllers of this type, with cheapness their only recommendation, have never been applied with success to large machines which operate frequently at partial loads. The inherent principle on which they work being to reduce the volume of intake air, it follows that the inlet pressure is correspondingly reduced until at very light loads the ratio of compression and the resulting temperature is so greatly increased that there is danger of explosions particularly in the high-pressure cylinder.

Frequent disasters of this nature have led to the recent employment of an auxiliary unloader placed in the discharge line from the final cylinder, this device being adjusted to open to the atmosphere when the intake to the low pressure is closed. In this way explosions are avoided; but the method of control is wasteful of power, the noise of discharge is disagreeable and the shocks accompanying frequent load changes are severe.

Another form of unloader operates to hold the inlet valves (which are usually of the Corliss type) wide open, but such a device, while once the best obtainable, for compressors of small and medium powers involves complicated valve gearing and is evidently unsuited for large units where only half of the load amounts to several hundred horsepower. The present day tendency toward higher speeds for compressors due to the proven practicability of mounting the motor rotors or armatures directly upon the crank shaft precludes, however, the possibility of employing releasing devices and antiquates the formerly efficient Corliss inlet valve.

These higher speed machines are even now supplanting units embodying what is unquestionably the most carefully designed, efficient and satisfactory variable capacity valve gear ever developed and applied to slow speed compressors. This gear is so regulated by the received pressure as to close in the proper sequence the inlet valves at any point in the suction stroke, thereby exactly proportioning the delivery to the demand. The criticisms of this device are its complicated mechanisms, the impossibility of adapting it to high-speed machines and the fact that the valves are alternately subjected to a partial vacuum and to a pressure with the result that unless lubrication is always effective serious leaks occur during both the loaded and unloaded periods.

A 4-step control which has stood the test of time, and of severe exacting service is one in which auxiliary clearance chambers are provided for each end of both the low and high pressure cylinders, these chambers being successively connected to, or cut out from, the cylinders by means of auxiliary valves which are controlled by the receiver pressure. For partial load conditions a portion of the air compressed at each stroke is retained in the clearance, this air consequently re-expanding on the return stroke and correspondingly diminishing the volume of the intake.

By simultaneously controlling clearance pockets on both the low and high-pressure cylinders, the ratio of compression is unchanged, the work is always equally divided between the cylinders and the compressor remains a cool, economical 2-stage machine regardless of the air requirements and of the speed. The additional cost of clearance chambers is offset by the elimination of valve gearing and the only disadvantage of the control would appear to be the possibility of leakage of the auxiliary valves with a resulting loss in volumetric efficiency at full load that could not be detected.

The insistent demand for higher speeds and the troubles then encountered with the older types of air valves have been recognized by several of the more progressive manufacturers of compressors, resulting in the adoption of a type of valve which has been very successfully employed for many years on the continent of Europe. These valves are of the flat disc design, light, give large areas for the passage of air, are practically indestructible and noiseless and operate without lubrication. They may be operated at the highest speeds and in

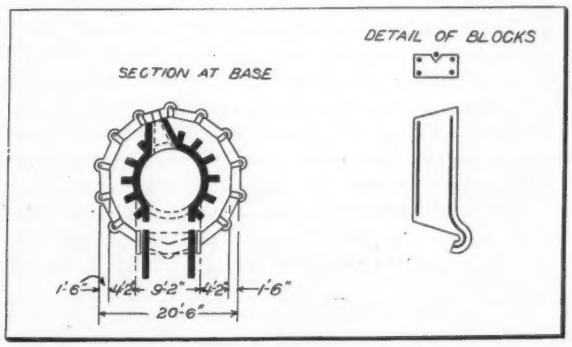
addition to their adaptability to the clearance controlled machines mentioned above have been employed in the development of a 4-step control which embodies at once the valuable elements, of theoretical correctness of design simplicity through the introduction of a minimum of parts, and the elimination of auxiliaries; and most important of all, a minimum power consumption at partial loads.

The principle of operation of this control is simply to hold wide open and in the proper sequence the inlet valves of both the low and high-pressure cylinders, thereby permitting of the expulsion of the air through ports which are amply large, keeping the cylinders cool, eliminating losses experienced with controls which affect the clearance and consequently reducing the power required at any load to an absolute minimum.

Capacity regulation in 4 equal steps is obtained by opening successively 4 sets of inlet valves on each cylinder, these valves all being under the control of a simple pressure regulator. The distribution of the inlet valves is novel and ingenious in that one set for each end of the cylinder is closed by the passage of the piston at half stroke and is consequently inoperative during the remainder of the stroke. From this, it is readily understood that with one set of these valves held open through the action of the regulator the effective stroke is shortened ½ and the capacity correspondingly reduced. Simultaneous operation of the control on both low and high-pressure cylinders is obtained by simply connecting their corresponding sets of valves to the same point on the pressure regulator, and as the action at each of the 4 steps of the control is the same, the load and temperatures are always equally divided between the cylinders regardless of the volume being delivered.

Reinforced Concrete Block Chimney

IN Concrete and Constructional Engineering is given an account of a 220-ft. reinforced concrete block chimney, built at Penarth, Wales, which has a number of interesting features. The chimney is 220 ft. high, with an outer shell of concrete blocks, and an inner lining of brick. These 2 parts are entirely separate throughout the entire height of the chimney, 220 ft. The outer shell is 14-sided, 20 ft. 6 in. in diameter at the base, and 1 ft. 6 in. thick, and at the top the outer wall is 10 ft. 4 in. in diameter outside, and 5 in. thick, giving a batter of 1 in. in 43. The inner shell is 9 ft. 2 in. in diameter at the bottom, and 8 ft. 6 in. at the top, and in thickness is 9 in. for the lower 183.5 ft., and 4.5 in. for the upper 24.5 ft., this lining being reinforced by radial ribs. The least clearance between the brickwork lining and the concrete shell is 6 in., the shell extending to within 12 ft. of the top, which was desirable on account of the high temperature of the gases. The outer shell has a cornice, at about 5 ft. from the top, and is capped with a cast-iron plate. The blocks, of which plan and cross-section are shown in the illustration, are of concrete, of proportions 9 cu. ft. of crushed granite, 5 cu. ft. of clean sand, and 3 cu. ft. of Portland cement, the granite being crushed to pass a ¾-in. sieve, and having all dust removed. This mixture was made by hand and molded in cast-iron forms, the reinforcing steel rods, which are of varying diameter, depending on the thickness of the blocks, being imbedded in the concrete during the process of molding. Setting for the blocks was a cement mortar, of proportion 1 to 2, and an additional reinforcement was obtained by the use of a steel rod extending around the chimney at each horizontal joint, as indicated in the cross-section of the block, and vertical rod at each joint where the ends of the blocks meet, these rods being placed inside the concrete hook, which is shown in the plan of the block. These vertical rods are carried down 6 ft. into the concrete foundation, and there attached to a horizontal steel ring, laid in the foundation.



DETAILS OF 220-FT. REINFORCED CONCRETE CHIMNEY

Hard burned red bricks were used for the lining, set in cement mortar, the same as that used for the block, up to the level of the intake flue. For the 9-in. brickwork above that level, the mortar used was a cement lime of the proportions ½ Portland cement, 1 part lime and 2½ parts sand. The upper, thinner part of the lining was laid in 1 to 2 cement mortar.

For the foundation, a concrete reinforced slab was used, 23½ ft. square, which gave a load on the subsoil of 2½ tons per square foot, the total weight of the chimney and foundation being 1400 tons.

DANGER FROM the use of inflammable material for roofs was well illustrated by the recent conflagration at Salem, Mass., where the blaze, after rapidly spreading from the factory outskirts to the center of the business district, jumped a mile by the carrying of blazing embers onto wood shingle roofs. Some fire-resisting roofing such as asbestos shingles or asbestos ready roofing would have retarded or prevented this spread as was shown by the fact that the storehouse of the Naumkeag Steam Cotton Co., which had asbestos roofing was unharmed, while buildings all about it burned to the ground. Such precautions as fireproof construction, and especially roofing, are a duty for the protection of life and property in every thickly settled district. The entire fireproof construction may be difficult to obtain in districts already built up, but fire resisting roofs are easily secured, by gradual recovering as repairs are needed.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Commutation and Commutators

Care of Commutators and Brush Adjustments. By Gordon Fox

TROUBLE due to sparking and rough commutators is by far the most prevalent difficulty with direct-current generators and motors. Often it is difficult to overcome the basic cause of the trouble experienced, obstinate cases being quite common. An endeavor will here be made to cover all ordinary causes of commutator and commutation trouble, to suggest remedies and to outline methods for repair and maintenance.

Commutators are of necessity delicate devices. Made up of a large number of segments of copper and mica-bond, they must be perfectly insulated, must be mechanically absolutely rigid, must retain a perfectly smooth surface though subjected to repeated heating and cooling and this surface must continuously carry electric currents having destructive tendencies. The commutator, being the weakest link in the machine, suffers from any faults of design and faults incident to the drive as well as faults in field, armature or brushes.

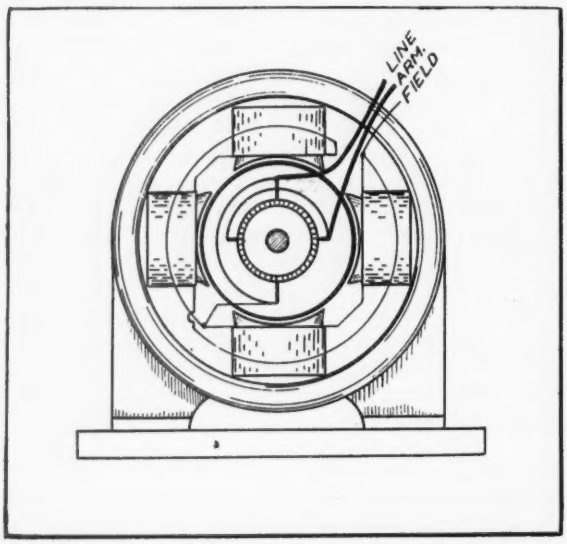


FIG. 1. SHOWING METHOD OF CONNECTING FIELDS IN SERIES PARALLEL

Field Conditions Bearing Upon Commutation

If the excitation is less than that for which the machine was designed, trouble is likely to result. This may occur in a motor by weakening the field to raise the speed or by operating upon low voltage. A weak field encourages exaggerated effects of armature reaction so that the commutating neutral point is widely shifted with load, causing sparking.

A nonuniform field may cause trouble. This might be caused by a short circuit of part of the turns in one spool, although this is an infrequent occurrence. It should be noted in this connection, that all the magnet spools on a given machine may not be alike; for instance, the north poles might have 2000 turns and the south poles 2500 turns and no trouble would result. The magnetic circuits then constitute pairs of poles and their spools are symmetrically located. Poorly spaced poles may cause sparking. Where pole pieces are cast into the yoke, it is difficult to secure perfect spacing. Bolted-in poles are usually more accurately spaced since they are drilled to jigs. The spacing between poles may be checked, using a large inside calipers for the purpose. On rare occasions, a poor casting is found, or one having poor magnetic contact at the base of a cast-in pole; such machines seldom leave the factory, however.

The eccentric position of the armature in the magnetic field may cause trouble, particularly in some types of armatures not provided with equalizers. In these cases, the brushes carry an equalizing current due to the difference in voltages of the various armature coils. In general, armatures should be placed central except in the larger machines, where they are raised about 1/16 in. above center, so that the upward magnetic pull may lift the weight of the armature from the bearings.

Sometimes the design of a machine is such that the effect of armature reaction is very pronounced, the neutral shifts widely with change of load and it is impossible to find a single brush position which will afford good commutation on all loads. In such cases, improvement can often be made by increasing the air gap. This can be done in machines with bolted on poles by removing a shim if there be one, otherwise it is necessary to bore out the field. With the greater air gap, it will be necessary to strengthen the field excitation, so that this remedy cannot be applied to machines in which the field coils run normally very warm. If there be no rheostat leeway for increasing the field strength, this can often be accomplished by reconnecting the fields in series parallel as shown in Fig. 1. A rheostat is inserted in series so that the strength may be governed as desired. An effect similar to that of boring out the field is sometimes obtained by chamfering the pole tips so that they become quickly saturated, limiting the amount of pos-

sible field distortion. In this case, also, it is usually necessary to strengthen the field somewhat to make up for the increased reluctance introduced by cutting away the iron.

Armature Faults and Their Effects

If a coil in an armature becomes short-circuited, a local heating is set up in this coil and the commutator bars connected to it. This often causes the armature to smoke. It heats up a few bars in the commutator, causing high bars, and sparking occurs. If it be very important to keep the machine in operation, it may suffice to cut one lead of the short-circuited coil and to run a jumper around, connecting it to the 2 bars to which the defective coil was connected.

An open circuit in a direct-current armature has decided symptoms. Instead of the ordinary brush sparking fine rings of fire commonly occur running from brush to brush or completely around the commutator. Then, if the machine be shut down it will be noted that the segments across which the open coil is connected will show pitted mica. If an open circuit cannot be repaired easily, the jumper method may also be used here to keep the machine in operation.

Faults Incident to the Drive

Periodic loads sometimes cause trouble by imposing peaks on the machine repeatedly at the same point in the revolution. This may occur with gear drives having exact ratios in connection with cyclic loads. Pumps or reciprocating compressors and the like may cause this trouble. A poor belt splice has been known to have the same effect. The trouble may be corrected, in the case of gears, by addition of a tooth to change the teeth meshing regularly. In the case of belted reciprocating machines, a slight change in pulley ratios may be helpful.

Vibration, due usually to mechanical unbalance, but sometimes because of mounting or by transmission from the driven machine, makes good brush contact difficult and is always detrimental.

If an armature is out of balance, the trouble may be corrected by addition of well secured weights. The proper location for these may be determined by trial or by placing the armature on level knife edgeways and locating the heavy side.

Commutator Faults

High mica is one of the most common causes of sparking and blackening of commutators. It is more frequently found in high voltage commutators, since these have relatively more bars with a greater percentage of mica segments. It is difficult to secure absolutely uniform mica which is of such hardness that it will wear away at exactly the same rate as copper. Particularly if there be any tendency to eat away the copper, the mica is likely to become high. When high mica occurs at any point, it results in causing a slight air gap between the brushes and the commutator. The current jumps across this gap, causing slight blue pin sparks under the brushes. This arcing tends to blacken the commutator at the point where the mica is high, making the contact still worse. The load is shifted to the other brushes of the same polarity, which now carry more than their proportionate load; consequently, burning and blackening are soon set up under these brushes, also, and there appear equally spaced spots, half as many as there are brush studs.

High mica may be detected by scratching the finger nail along the surface of the commutator. The trouble may be due to hard mica in the segments or to soft brushes, which have insufficient abrasive quality. The most common remedy is undercutting, and this is becoming quite common practice. The undercutting may be done with a small rotating saw or milling cutter, or with a hand tool. There are a number of commercial portable devices for undercutting mica. A satisfactory job of undercutting can be accomplished with the use of a small 3-cornered file which has had the end broken off about 1 in., the end being ground square across. This may be used as a chisel, starting at the outer end of the segment and working toward the risers, holding the tool nearly flat so that the belly of the file will run in the groove and guide the tool. A stiffened hack saw blade may also be used for this work. The slot should not be more than 1/32 in. deep. A tapering slot such as is obtained with the 3-cornered file is excellent, the upper sharp corners being slightly rounded to prevent cutting

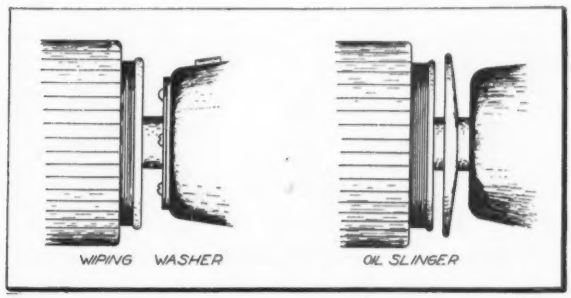


FIG. 2. DEVICES TO PREVENT OIL FROM REACHING COMMUTATOR

the brushes. The only disadvantage with undercutting is due to the possibility of dirt gathering in the slots. This is an infrequent trouble, since centrifugal force will usually keep them clean; but regular inspection and cleaning with a stiff brush are desirable.

Commutators often run out of true, due to a bent shaft, looseness in the bearings or to thrust incident to the drive. Large engine-driven generators usually have their commutators turned while the armature is mounted on a test shaft. Later, this shaft is pressed out and the engine shaft inserted, which often results in slight eccentricity.

Eccentric or oval commutators sometimes result from excessive loads which heat them up and distort them. New commutators are subjected to a gradual seasoning out. At the factory they are baked and tightened and later run; but they are seldom subjected to heating and centrifugal stresses simultaneously, hence, when placed under load in service, there may be a little yield at points. This seasoning out of commutators is a slow and gradual process, so that it may be necessary to tighten and true up the commutator several times before a permanent condition is obtained.

Another commutator trouble is displaced bars, either high bars or flats. These are caused by heat and cen-

trifugal forces similar to seasoning troubles. Tightening and turning are the usual remedies and it may be necessary to repeat the process before the final set is reached. Sometimes shrink rings are necessary to prevent high-speed commutators from distortion. These are micabond bands which are tightly bound outside the commutator with steel wire bands. The commutator is then baked so that the mica sets in place. The bands are then removed and the mica turned to a slightly larger diameter than the bore of the shrink ring, which is then heated and slipped over the mica band, and on cooling, holds the commutator securely against centrifugal strains.

In remedying seasoning faults, it is often desirable to heat the commutator and to tighten it in order to cause the insulating rings to fill all possible spaces to make a solid mechanical unit. The following method is suggested for heating large commutators in service. Shift the brushes materially from the neutral point. Run the machine as a generator at low voltage and short-circuit the armature or load it on a low resistance.

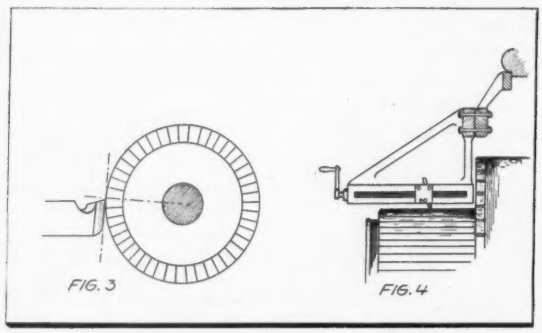


FIG. 3. POSITION OF CUTTING TOOL
FIG. 4. COMMUTATOR TRUING DEVICE BOLTED TO BRUSH HOLDER RING

Adjust the field strength so that about full load current passes through the armature. Due to the shifted position of the brushes, there will be a considerable local heating in the commutator caused by the current passing from segment to segment across the brush. This will heat the commutator without unduly heating the armature. When the commutator is thoroughly heated it should be tightened, allowed to cool and tightened again if there is any looseness at any of the bolts. This process should remove most of the yield from the commutator. It may now be turned or stoned and placed in service again.

Pitted mica is a frequent occurrence in commutators. This appears as rotting or blackening of the mica so that soft places or holes appear. These cause partial short circuits, being leakage paths between bars. Sometimes a whole commutator will run hot, due to leakage through carbonized mica; but more commonly the trouble is confined to one or more spots. The most vulnerable points seem to be at the outer end of the commutator. When these holes or rotted points appear, all the blackened mica should be thoroughly dug out and the space thoroughly cleaned with a pointed piece of hack saw blade. The hole may then be filled with a mixture of plaster of paris and powdered mica, using enough shellac to form a thick paste. After filling, the region should be heated to cause the filler to set, and may then be smoothed off. Other materials such as dentist's cement or the special commercial preparations may be successfully used as fillers.

The common cause of rotting mica is oil. It is often found that oil not only causes rotten mica between segments but that it also rots the end clamp rings and causes grounds. Oil causes the mica to carbonize, hence should be used sparingly as a lubricant, and leakage from the bearings or elsewhere should be avoided. It is often found that oil will creep along the shaft out of the bearing and will then work out past the clamp ring onto the end of the commutator, but this trouble may be remedied in one of several ways. If oil V grooves on the shaft are ineffective, a wiping washer (sole leather is good for this purpose) may be built on the inner end of the bearing housing as shown in Fig. 2. Another method is by placing oil slingers so that they will prevent creeping oil from reaching the commutator. Due to centrifugal force, the oil may reach the periphery of the slinger but cannot proceed radially inwards again, so that it is thrown off. The inner and outer corners of the commutator should be rounded and the outer face should be thoroughly painted with insulating paint, as sharp corners seem to be the first points to carbonize.

Nearly all commutators require occasional turning, due either to wear or to roughening from one cause or another. Small commutators can best be turned in the lathe, while a large commutator is most easily turned in its own bearings. The surface speed for turning should be about 500 ft. per min.; the tool should be sharp and ground and set as shown in Fig. 3. If a second cut is taken, a tool with a blunter nose may be used, as it will leave less of a tool mark. After the commutator is turned, it should be filed with a large mill file sparingly to remove tool marks, but not enough to cause an untrue cylindrical surface. Final smoothing may be done with sandpaper; but a fine sandstone is preferable, as sandpaper will give and ride over the mica, whereas a stone will abrade the entire surface uniformly. Before switching current into a newly turned commutator, a careful inspection should be made to see that no copper has been carried over between bars, and if the commutator is to be undercut, this should be done after turning. When the armature is again placed in service, it is well to run without load for a period, to work in the commutator and brushes and to acquire something of a polish. After the commutator has been in service a few hours, it is well to lift the brushes and scrape off any particles of copper that gathers upon them, due to the raw condition of the commutator. Polish can be hastened by giving the brushes additional pressure for a time.

There are a number of commutator truing devices on the market, these being simply some form of tool support fitted with hand wheel and screw for moving the tool along the commutator. They are usually bolted to the bearing pedestal or to the brushholder ring as shown in Fig. 4. Due to the fact that when a commutator is trued at low speed it may not be true at high speed, the practice of grinding commutators is becoming common. A grinding wheel may be used or a stationary block may be substituted for the turning tool and fed across the face of the commutator under pressure, sandstone being the best material for this purpose.

When truing any commutator, it is well to place a cardboard shield in front of the risers and windings to prevent chips of copper from lodging where they may cause trouble. If a commutator is turned, ground or sanded while in position, the brushes should be raised to prevent collection of copper and they should be cleaned before again lowering them.

Brushes and Brush Troubles

The main function of brushes is of course to collect or deliver current, but they are also called upon to abrade the commutator properly and to furnish lubrication. Carbon brushes of different qualities are almost exclusively used. Different grades are suited to different purposes, the voltage design features having a bearing. Low voltage machines may have low resistance brushes, whereas high voltage machines usually require brushes of higher resistance. This is necessary in order to limit the current in the short-circuited coils under the brushes. Since, in the high voltage machines there are more armature turns, the voltage between segments at reversal is higher. Railway motors are subject to severe peaks and flashes and brushes for this service must have sufficient abrasive quality to remove slight commutator imperfections quickly. On the contrary, low voltage turbine generators having high commutator surface speeds require soft, graphitic brushes to reduce commutator wear to a minimum. Between these limits lie a variety of conditions and a variety of brushes. To determine the most suitable brush is generally a matter of trial. Aside from the quality of brushes, their relative width, their angular position, tension, fit in the holders, current density, spacing and position are factors of importance.

The width of brushes is determined in design according to the current to be carried, the available length of commutator and the current density to be allowed. Where brushes run hot and glow, but do not spark, a wider brush may sometimes be used to advantage. Sparking, on the other hand, may sometimes be due to wide brushes. The allowable width of brush depends upon the width of the neutral zone, as will be mentioned later.

The angular position of the brushes is often important as bearing upon their contact. Brushes for reversible motors should be radial, others should have an angle of about 15 deg. from radial with the outer end of the brush in advance of the face. The brushes should be in front of the brush stud, that is, toward the rotation. This arrangement, properly carried out, forces the brushes to be driven onto the commutator by slight roughness rather than knocked away from it; consequently, commutation is better.

Brush tension varies according to size and service. Railway motors require about 5 lb. per brush, while tension on most ordinary machines should be about 2 lb., except for the smaller sizes, where the tension should be less. The lighter the pressure the better, as long as good commutation is obtained. Uniform tension is important since it affects the distribution of the current, particularly in large, heavy current machines, since in such machines it is easy for a brush having better contact than its neighbors to become overloaded and glow. Overloaded brushes are more likely to pick up copper and to become honey-combed on their under surface. Honeycombing of brushes, although sometimes caused by electrolytic action, is more frequently due to overloads, either of main current or local brush current between bars.

It is important that brushes fit snugly in box type holders in order that they may not rock and chatter. On the other hand, they should be free enough to slide easily with the spring tension used. The copper plating on the brushes should always be scraped off about ¼ in. from the commutator, otherwise the current will be localized at the outside edges of the brushes.

The brush pressure is best applied at the trailing edge of the brush rather than at the center. The tendency of commutator friction is to rock the brush, concentrating the pressure on the leading edge, and if the spring pressure be applied on the trailing edge, it has a counteracting effect which should secure uniform pressure over the entire brush. A good brushholder and its proper setting are shown in Fig. 5.

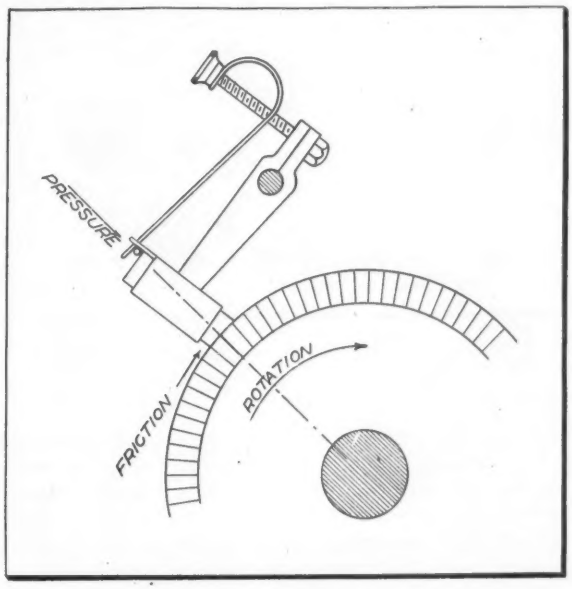


FIG. 5. BRUSH PRESSURE SHOULD ACT RADIALLY ON COMMUTATOR

The face of the brushes should fit the curvature of the commutator closely. The best method of sanding brushes is by the use of short, narrow strips, working in a few brushes at a time. If the brushes are in box type holders where they have a chance to rock, they should be sanded by drawing the paper in the direction of rotation, lifting the brushes and returning the paper and repeating. This assures a fit for the actual running position of the brushes. Where at all possible, the brushes should be staggered to prevent wearing the commutator in grooves. A natural oscillation will ordinarily aid this, provided all the end motion may be overcome by gravity, or the combination of gravity and magnetic centering effect may counteract to cause end pounding.

The position of the brushes with respect to the neutral position is of course fundamentally important. The first requirement is the symmetrical spacing of the

brushes. This condition can be most easily obtained by the following method: Cut a strip of heavy paper about 1 in. wide and somewhat longer than the circumference of the commutator. Slip it around the commutator under the brushes, allowing the ends to overlap. Cut both end layers simultaneously along a mica segment as shown in Fig. 6. The paper is now of length exactly equal to the circumference of the commutator. Next, remove the paper and divide it into as many sections as there are brush studs. This is easily done by folding 2 or more times and marking along the folds. Reinsert the marked strip under the brushes, as shown and set the edges of the brushes to the marks. This method is simple and gives accurate results.

The brushes being properly spaced, must next be shifted to position. Consider first the shunt or compound wound machines in which the neutral position shifts more or less with the load. In a generator, the neutral shifts with rotation; in a motor, against the rotation with increase of load; therefore, motor brushes are set as far against the rotation at no load as will

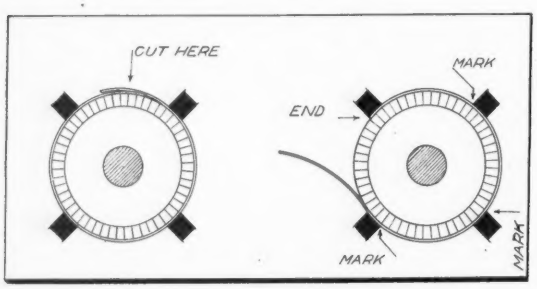


FIG. 6. SHOWING METHOD OF SPACING BRUSHES EQUALLY BY MEANS OF A STRIP OF PAPER

secure sparkless commutation; generator brushes are set as far with the rotation as will secure sparkless commutation at no load. Shifting motor brushes against the rotation increases the motor speed and some adjustment of speed is possible by this method; but the rule should always be, "commutation first."

Interpole machines are supposed to retain the neutral at one point for all loads. This they will practically accomplish, if properly adjusted. The best way to locate the brushes of an interpole machine is to run the machine without load as a motor, first in one direction and then in the other, changing the brush position until the speed is exactly the same for both directions.

If an interpole be of proper strength, it will retain the neutral fixed; if it be too weak, the neutral will shift as in a shunt machine; if it be too strong, the shifting will be of opposite effect. For motors, the interpole may be adjusted by running the motor first at no load and then at full load with brushes at the reversible point; if the motor slows down with increase of load, the interpole strength may be insufficient; if the motor speeds up with increase of load, the interpole is too strong and should be shunted with German silver resistance. A perfect interpole adjustment will provide nearly the same no load and full load speeds.

To determine the proper strength for a generator interpole is a little more difficult. The use of a low-reading voltmeter and exploring leads gives the most satisfactory results. A pair of voltmeter leads arranged to span across 2 segments of the commutator is moved along the face of the commutator at the brushes. At the neutral point the voltmeter reads zero; on one side of the neutral it has a positive reading and on the other side a negative reading. It is therefore easy to locate the neutral zone, to determine its width, to find the voltage between segments near the neutral and other useful data. In the case of interpole generators, the neutral should remain fixed at all loads. The exploring method will show whether it does so, and its strength can be adjusted by shunting with German silver until this condition is obtained.

Proper cleaning and lubrication of commutators are preventives of the highest order. A very little dynamo oil is a good lubricant. Pure wax is good, and it encourages a gloss; but it should be applied only to a warm commutator, since it will gum if cold. A canvas pad without lint is the best cleaning and oiling medium.

Trouble Due to Short Circuit

By J. A. Horton

IT is a well known fact that, if the field circuit resistance of a shunt generator be too high or the resistance of the external circuit too low, the generator will fail to "pick up."

A short circuit on the distributing lines connected to or fed by a shunt machine produces the low resistances of the external circuit mentioned above and will cause the generator to lose its field, discharging its energy into the armature and external short circuit.

The accompanying illustration indicates the armature connection, A, field connection, f, pilot lamp, l, external load, L, and circuit breaker, B, of a shunt-wound generator which was reported to have flashed at irregular intervals in which the flashing was accom-

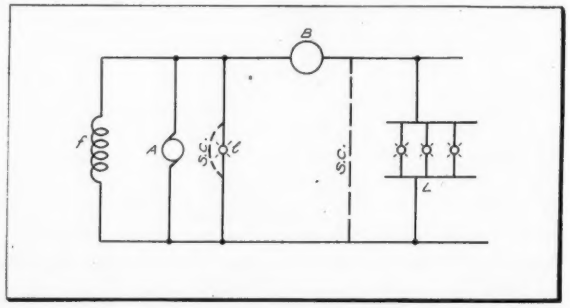


DIAGRAM OF CONNECTION SHOWING LOCATION OF TROUBLE

panied by the opening of the circuit breaker and blinking of the pilot lamp. When, however, the circuit breaker was closed again, normal operation would be resumed.

One day, due to a swinging short circuit followed by the "freezing" of the lines and forming a permanent contact, the circuit breaker stuck and failed to operate, the pilot lamp was blown up, the machine dropped its field and generation could not be restored with the breaker either open or closed.

It was readily seen that, due to the external line short circuit, the machine could not build up; but it

remained somewhat of a mystery why this condition should remain after the outside trouble was cleared. This, however, was solved when, after some investigation, there was found a second short circuit in the pilot lamp receptacle as indicated in the diagram.

After both short circuits had been removed, the machine was started and "picked up" as nicely as formerly.

Practical Electrical Engineering

DIRECT-CURRENT SWITCHBOARD CONNECTIONS. BY NORMAN G. MEADE

FIGURE 1 shows the simplest type of direct-current switchboard connections, for the control of 1 shunt-wound, direct-current generator. The apparatus on the panel consists of a main and a field switch, a field rheostat, a volt and an ammeter. A panel of this

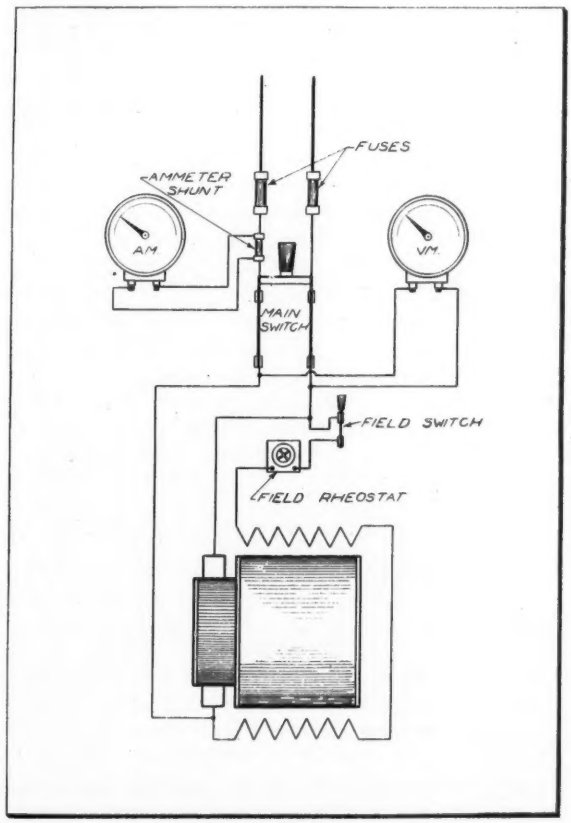


FIG. 1. DIAGRAM OF CONNECTIONS FOR SHUNT-WOUND GENERATOR AND A SIMPLE FORM OF SWITCHBOARD

type is suitable for small isolated plants supplying principally a lighting load. Obviously, if so desired, a circuit breaker can be substituted for the fuses; it is customary, in modern practice, to use such a device on one side of the circuit only.

Connections for 2 compound-wound generators operating in multiple with an equalizer were shown in the article on the erection of generators.

For low tension distribution, 3-wire circuits are frequently used, generally operating at 110 volts between the outside wires and neutral and at 220 volts between the 2 outside wires. The 3-wire system has the advantage of a saving in copper and the availability of 2 voltages, the smaller for lighting purposes and the larger for power. There are several ways of obtaining 3-wire

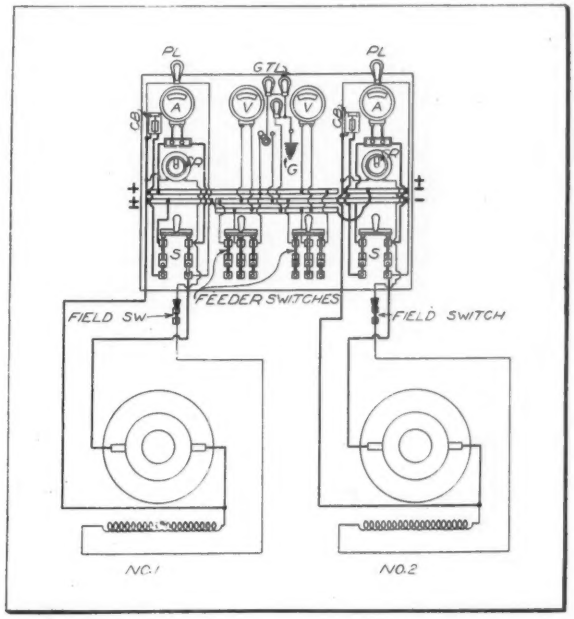


FIG. 2. TWO SHUNT-WOUND GENERATORS OPERATING IN SERIES ON A 3-WIRE SYSTEM

systems, the oldest being to connect to 110-volt generators in series, taking the neutral tap from the junction of the positive of one machine with the negative of the other machine. Another method is to employ a 220-volt

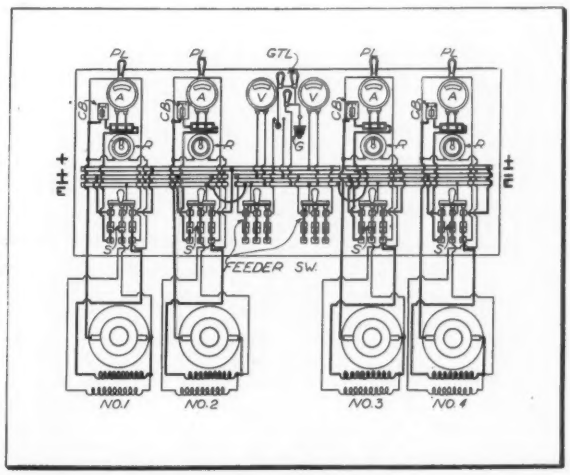


FIG. 3. TWO SETS OF 2 GENERATORS OPERATING IN SERIES ON A 3-WIRE SYSTEM; GENERATORS OF EACH SET ARE CONNECTED IN PARALLEL

generator using a neutral wire which is connected to the system by means of a motor generator balancing set. The most modern 3-wire equipment consists of a 3-wire, self-contained generator.

For any of these equipments, the switchboard connections are practically the same. Figure 2 shows the switchboard connections for 2 shunt-wound generators

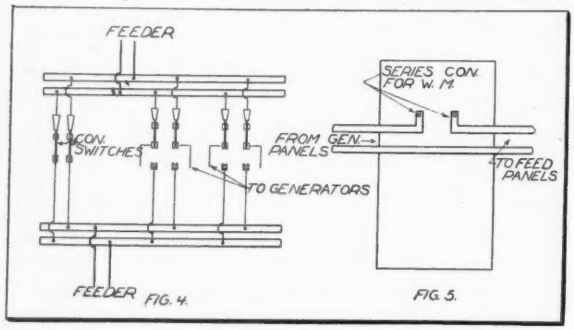


FIG. 4. DIAGRAM OF SWITCHBOARD HAVING 2 SETS OF BUS BARS

FIG. 5. BUS BAR CONNECTION ON REAR OF TOTALIZING PANEL

operating in series on a 3-wire system. In the figure, +, — and ± indicate respectively the positive, the negative and the neutral bus bars. The generator switches are 2-pole and the feeder switches 3-pole. On

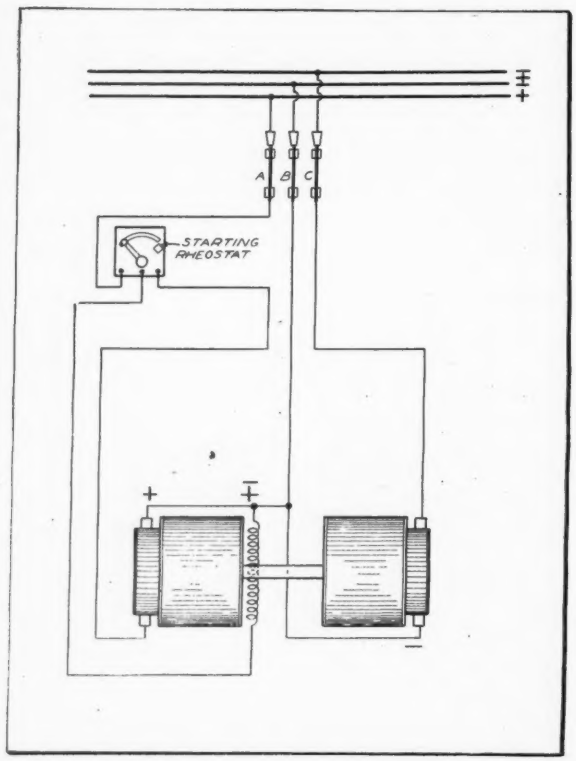


FIG. 6. CONNECTIONS FOR A PANEL CONTROLLING A MOTOR-GENERATOR BALANCING ON A 3-WIRE SYSTEM

each generator panel there are, besides the main switch, a circuit breaker, C B, an ammeter, A, field rheostat, R, a field switch, and a pilot lamp, P L. The voltmeters, V, are placed on the feeder panel, one connected to each side of the system. By this arrangement, any unbalancing of the system will at once be apparent by the difference in voltages.

The ground detector switch is located between the voltmeters and is so connected that 2 lamps are in series to indicate a ground on the high-voltage side of the system while a single lamp indicates a ground on the low-voltage or neutral.

Figure 3 is a diagram of connections showing the operations of 4 generators, 2 of each being connected in parallel, on a 3-wire system; the panels are provided with the same instruments and apparatus as those shown in Fig. 2, with the exception that the generator switches, S, are triple pole, the center pole acting as the equalizer switch.

Switchboards are frequently equipped with 2 sets of busbars, where there are 2 or more generators, as shown in Fig. 4, which are generally arranged so that the 2 sets of bars may be connected together by connecting switches as shown in the figure. The generators are connected to double-throw switches so that each machine can be connected to either set of busbars, thereby enabling one machine to take care of a portion of the load and a second machine, another part. As shown in the diagram, the 2 generators are operating in parallel, supplying the whole load.

Figure 5 shows the busbar connections on the rear of a totalizing panel. The entire current output has to pass through this panel, which may have various equipments as already pointed out. The usual equipment for feeder panels is a feeder switch, an ammeter and a circuit breaker.

In Fig. 6 is shown the schematic connections for a switchboard panel to control a motor generator balancing set for a 3-wire system. One side of the balancer is started up as a direct-current motor by means of a starting rheostat after switches A and B, connecting one outside wire and the neutral are closed. When the machine reaches normal speed, switch C is closed.

EXPERIMENTS and experience with internal combustion engines, show that the temperature of the water supplied to the jackets has considerable effect upon the water consumption. To get the best results, the discharge temperature should be as high as possible without generating steam in the engine jacket, somewhere in the neighborhood of 180 deg. If the water is cool when it enters the jacket, it can be retained for a longer time before it will reach the maximum desirable temperature; so that the amount required will be less. Evidently, for an engine running underloaded, the fuel and water consumption per horsepower will be higher than at full load, and it is found that the fuel per horsepower will possibly be about 1¼ times as much at ⅝ load as at full load, and the jacket water consumption about 1½ times. At ⅜ load, the fuel consumption will be about 1½ times that per horsepower-hour for full load. Considering 55 deg. as the average initial temperature for the cooling jacket water, the amount required when the water is 45 deg. will be about 0.94 that for 55 deg., and at 35 deg., will be about 0.87 as much as at 55 deg. With temperatures above 55 deg., the consumption will be higher, being 10 per cent greater at 65 deg., and 20 per cent higher at 75 deg.

Compact Water-Tube Boiler

NEW TYPE OF ENGLISH BOILER

THE Kestner Evaporator & Engineering Co., Ltd., of Westminster, London, England, has developed a boiler whose heating surface is composed entirely of vertical tubes which, by their upright position, avoid lodging of soot on them, and as the tubes are perfectly straight and free to expand, prevent leakage of the tube plate.

Referring to Fig. 1, which shows a water-tube boiler of this type arranged for combined coal firing and gas firing, and combined with a superheater and economizer, the boiler will be seen to consist of a steam or upper drum, 1, and a mud or lower drum, 2, which are united by a double row of tubes, 3, the tubes being expanded at their ends into the drums. The upper or steam drum is of large diameter, thus giving ample steam reserve. On its lower side, the plate forming its shell, has the tubes milled out. The mud or lower drum is of smaller diameter and has on its upper side a corresponding number of holes milled. These 2 drums are united by the tubes, which are arranged so that in plan they form a continuous W, there being 2 rows in each arm of the W, as shown in Fig. 2.

The evaporating tubes, 4, Fig. 1, are either 2 3/16 or 2⅜ in. in diameter. About the center of the arm of each W, a number of larger tubes, 5, either 3¼ or 4 in. diameter are arranged and in these latter, similar concentric tubes, 6, open at both ends and supported by means of spiders, the lower end of the outside tube being expanded into the bottom drum while the lower end of the similar internal tube projects into the lower drum, somewhat as shown in Fig. 3.

Water is fed into the boiler at the top, that is to say, into the steam space above the water level, through an inverted elbow to the feed-water distributing trays, 7, which run nearly the whole length of the steam drum. The colder water then passes down the inner downcomer tubes and on striking deflectors, has its velocity reduced previous to its return to the steam drum by means of the evaporating tubes, 4 and 5. As the steam drum is of ample size and each tube does an equal amount of evaporation, the free steam is discharged equally from the tubes all over the drum so that it is possible to obtain perfectly dry steam. In cases of demand being put on the boiler to supply a large quantity of steam immediately, a drier, 9, is put in the steam drum so arranged that under any conditions dry steam can always be obtained.

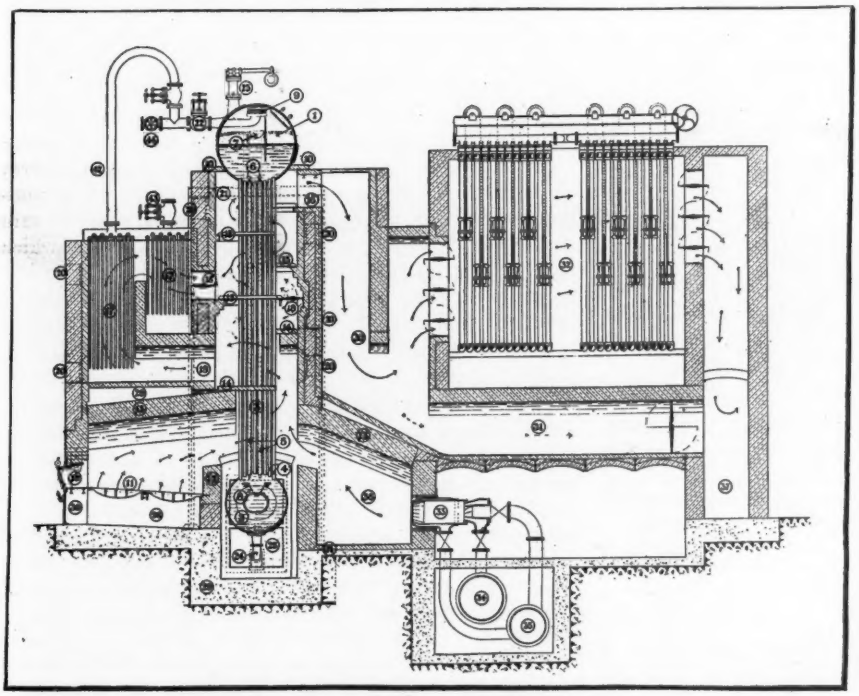


FIG. 1. KESTNER STEAM GENERATING UNIT

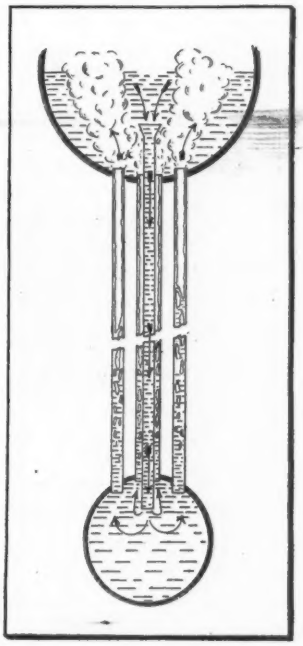


FIG. 2. TUBE ARRANGEMENT OF KESTNER BOILER

Tubes are easily replaced, the fire brick slabs, 10, Fig. 1, being removable and easily taken off to allow a tube to be withdrawn and the new tube put into position. Tubes in the standard boiler are 23 ft. long; but where head room is of importance, shorter tubes can be used.

The boiler is supported by the upper or steam drum resting on a steel staging, 21, the lower or mud drum hanging from it by the tubes, and as all tubes are heated equally, they expand freely and equally. They receive the greatest heat at the bottom where there is more water, while at the top they are only submitted to moderate heat. The return water tubes, 6, on which the circulation depends, are not directly heated by the gases and do not produce steam.

The grate, 11, is placed on a level with the mud drum, 2, and in front of it, this drum being shielded from the flames by a fire brick wall, 12. Over the grate is placed an inclined combustion arch, 13, which is continued up to the tubes and fire brick baffles and arranged to fill up the gaps between the tubes, so that the gases pass across the tubes at right angles and are deflected from side to side by cast-iron baffles, 15, until, after 7 or 8 passages between the tubes, they enter flue, 16, of the chimney, their temperature here being about 450 deg. F.

A superheater is arranged directly over the grate, the gases first passing the tubes of the boiler, then around the superheater, 17, and after that continuing their passage between the boiler tubes. The quantity of gas passing round the superheater can be regulated by a damper, 18, so that any degree of superheat can be obtained. A further damper, not shown, is provided at the passage marked 19, so that when superheat is not required, both dampers may be closed, isolating the superheater completely from the rest of the boiler, so that the superheater can be overhauled or removed while the boiler is working. It is not required to flood the superheater when that is out of operation. It will be seen that any standard economizer can be used in conjunction with these boilers as occasion demands. Figure 1 shows the Kestner boiler and superheater arranged to be fired by coal or gas. At the right-hand side there is an installation for burning coke oven or blast furnace gas, complete combustion being obtained by means of burners and an ample combustion chamber, this preventing any blow-pipe action of the flames on the tubes. At the opposite side of the boiler is shown a complete hand-fired grate so proportioned as to be able to burn sufficient coal to give the full boiler output. The arrangement is such that the boiler can be fired by either coal or gas or simultaneously. As the conditions required for the combustion of gas and coal are not the same, each method of heating may have its conditions regulated to suit itself, which is not possible where the same combustion chamber is used for both coal and gas firing. Where unclean gases are used, the dust falls into the soot pit, from which it may be removed while the boiler is working under full load.

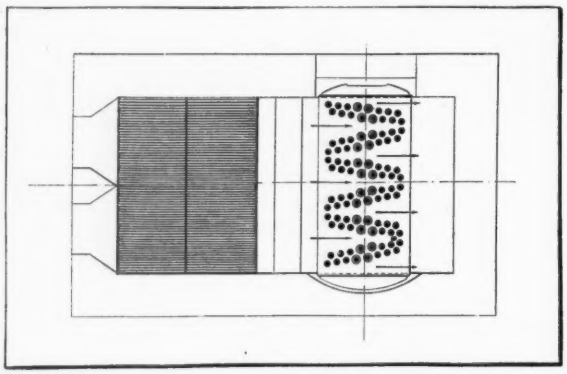


FIG. 3. HORIZONTAL SECTION OF KESTNER BOILER

The originality of the design inducing rapid circulation and high rate of combustion of inferior fuels, and the practically self-cleaning nature of the boiler make the Kestner boiler a most interesting study.

High Duty Dry Vacuum Pumps

By J. L. Brown

LITTLE is ever said of the dry vacuum pump, yet it is one of the principal factors of the high efficiency we are getting today in the large turbine plants. As we all know the turbine is not a very economical machine unless it is run on a high vacuum. For instance, the economy to be obtained by higher vacuum may be illustrated by the following example:

Suppose a turbine to be supplied with saturated steam at 205 lb. absolute pressure and the vacuum is 25 in. The efficiency of the turbine can be considered as its heat absorbing capacity. The heat in a pound of saturated steam at 205 lb. absolute pressure is 1198.5 B.t.u. and the heat in a pound of steam at 25 in. vacuum is 1118.4 B.t.u., the difference being 80.1 B.t.u. of heat which is absorbed by the turbine in doing work. Similarly, at any other vacuum the heat absorbed per pound of steam can be obtained; at 29 in. vacuum, the heat per pound of steam is 1094.3 B.t.u., a difference of 104.2 B.t.u. Therefore, the increase in heat absorption per pound of steam from a 25-in. and 29-in. vacuum is 104.2 — 80.1 = 24.1 B.t.u., or a gain of 30.08 per cent more heat is absorbed at 29 in. vacuum than would be at 25 in.

In a similar manner, the percentage of gain in heat absorption for various vacuums can be obtained by plotting graphically with vacuum as abscissa and the gain in heat as ordinates; this would produce a curve which rises rapidly as the vacuum is increased. The prime requisite to the maintenance of high vacuum with the resultant economy in the operation of the condensing apparatus, is that all enhanced air must be removed from the condenser.

There are various ways in which it is possible for air to find its way into the condensing system. For instance, there may be an improperly packed gland, or slight leaks in the piping, or air may be introduced with the injector (where jet condensers are used). The air should be removed before it reaches the condenser; this is accomplished by means of the dry vacuum pump, which is different from the ordinary air pump that is used in connection with a condensing system. The air pump handles no water, the cylinders being lubricated in the same manner as a steam cylinder. The air discharged by the dry vacuum pump at atmospheric pressure and temperature from units of about 5000 kw. in size varies from 1 cu. ft. per min. when the units are in the best condition to 15 or 20 cu. ft. where ordinary leaks are present, and 30 to 40 ft. where the units are in very bad condition. Most of this leakage comes into the condenser and exhaust passages through minute leaks in cast-iron shells, gaskets and expansion joints.

It is exceedingly hard to detect these leaks with a candle flame, but most of them may be detected by filling the condenser with warm water under a slight head. That portion of the leakage occurring in the dry air pump and piping is larger than is generally supposed. It is evident that the volumetric efficiency of a pump working between ¼ and 15 lb. absolute is very poor. The difficulty of keeping valves, pistons, glands and packing tight against such a tenuous fluid as air

at vacuum pressure is of much greater moment than is usually believed. It is hoped that some of the types of kinetic air pumps now being placed on the market will reduce the difficulty to a practical amount.

One of the large plants in the east has adopted the following method of testing for air leaks. The discharge pipe of the air pump is piped to a barometer bell in the vicinity of the air pump. After the air pump has been running for a sufficient time to make sure that the conditions are constant, the valve is opened and the discharge from the air pump is allowed to enter the bell, allowing it to rise. The time to fill the bell is noted and from this data the amount of air is calculated. The air in the bell is brought to atmospheric temperature before the final readings are taken. Tests are then run with the pump shut off from the condensers to determine the air leakage in the pump itself, and also the suction piping blanked off from the condenser to determine the pipe leakage. Readings should be taken, during the time necessary to fill the bell, of the air temperature in the bell, the air suction temperature, air discharge temperature, vacuum at the top of the condenser, vacuum in the air suction line to the pump, hot well temperature, circulating water inlet and outlet temperature, revolutions per minute of the pump, and power delivered by the prime mover and sometimes indicator cards on both steam and air cylinders. As we all know, the falling off of vacuum with increased air leakage is considerable and any work done to maintain tight condensers more than pays for itself.

Heating System as Applied to Factory Buildings

POINTERS IN THE SELECTION OF HEATING SYSTEMS; THE COMPOUND SYSTEM. BY H. S. BOWERS

As most of our factories are run by steam power with engines noncondensing, we have exhaust steam as a by-product, and heating engineers have studied out and experimented with various methods by which the varying conditions may be met, with the greatest economy.

We find that for each horsepower developed in a single engine, approximately 100 sq. ft. of heating surface or radiation may be supplied from the exhaust in the coldest winter weather. In round numbers, therefore, 10,000 sq. ft. would be fully supplied from an engine developing 100 hp. This 10,000 sq. ft. of radiation would heat a space of 800,000 cu. ft., figuring 80 cu. ft. of air per square foot radiation, heated from 10 to 65 deg. F. or a space 160 by 200 by 25 ft. high.

This ratio of 1 to 80 is not given as an infallible factor, but it is about an average. In figuring radiation I always use a factor which I determined by considering all the conditions which are known; this factor varies and is a problem itself and takes into consideration the cooling effect or heat lost through glass surface, wall surface and roof surface.

A short simple rule which is called the 2-20-200 rule is easy to remember. This, understand, is for exhaust steam at temperature of 212 deg., and radiation is to be direct pipe coil radiation or cast-iron radiators set near the outside walls.

Take the square feet of glass and outside doors, divide by 2.

Take the square feet of the outside wall, divide by 20.

Take the cubic feet of air or cubic contents of the room, divide by 200. Add the 3 results and your result will in almost every instance give you ample radiation surface for 70 deg. inside when it is zero outside.

As I stated before, this is a simple ratio rule and easily remembered,—2-20-200—first the glass, ratio 2 to 1; then the outside wall surface, ratio 20 to 1; next the air (which is easily kept warm when the exposures or heat lost is offset by radiation surface)—ratio 200 to 1. There are, however, many methods of determining the amount of radiation to be used for various purposes and it is handled on the heat unit basis. A heating engineer is frequently called on to determine the amount of radiation necessary to produce extremely high temperature in dry kilns up to 180 deg., in enameling driers 250 deg., in foundries where they want only 45 deg. to be provided by the heating system and again for heating a given amount of water or perhaps other liquids, especially in breweries, by a steam coil placed within a vat or tank, and contractors usually must figure the minimum amount of heating surface necessary because it always makes the bid look better when the cost of the work is reasonably low.

An Inefficient Back-Pressure System

THE OLD style gravity system, where the exhaust was forced into the system, under a back pressure, sometimes showed a greater total cost in the steam plant than it would have cost if the engine exhaust were opened full to the atmosphere and the heating done by direct live steam from the boilers. I personally demonstrated this fact in several instances. I had been soliciting a concern trying to interest them in a new heating system for their old works; there was little additional radiation to be used and the total amount used amounted to something like 1800 sq. ft., which they were supplying from the exhaust of a 60-hp. Corliss engine with a back pressure of 6 lb. (gage pressure). I told the proprietor that it was not economical for him to use his exhaust steam for heating and that he had better use live steam direct from boilers or else let me put in a system that would circulate at atmospheric pressure.

He laughed at me when I told him to shut off the exhaust heating system and waste the steam. His conditions were almost perfect for a demonstration, as his coal per day did not vary more than 100 lb. from the average. I offered to pay all the extra expense of coal if he would make a week's run using live steam only for heating, and it was further agreed that if I showed that it cost no more to heat by live steam while the exhaust was being wasted, than it had cost as he had been working, the owner would sign up a contract according to a proposal I had made him.

We saved the owner during the experimental run (using live steam for heating) just $4.20 in coal for the week's run and we saved him the cost of the new system in 3 months' run after it was installed, because we used exhaust and produced excellent circulation with 1-oz. back pressure.

I know of places, many of them, too, where the owner or superintendent or engineer, are so imbibed with the idea of exhaust heating that they will put 5 lb. back pressure on a 200-hp. engine just to heat 2 or 3 small coils. In one instance 250 sq. ft. of pipe coil radiation only was being heated by exhaust. Roughly speaking, this engine was consuming 18 per cent more steam or 36 hp. on account of 6 lb. back pressure only to heat 250 sq. ft. of radiation which, when run from direct live steam, would use only 2 or 3 hp. as against the 36 hp. loss in engine.

To overcome this great waste caused by back pressure, the system necessary is what is known as the return line vacuum system. This system is easily understood. The system consists of a supply main which is carried from the power plant. This main pipe is supplied from the exhaust main direct, also from the live steam high-pressure header with reducing pressure valve in the high-pressure connection.

The reducing pressure valve is set to open, and automatically admit live steam when the pressure on the heating main falls below a fixed point. This valve should be set to open at a point about ½ lb. lower than the point at which the back-pressure valve on exhaust pipe opens. If the back-pressure valve is set to open at ¾ lb., the pressure-reducing valve should be set to open at ¼ lb. to insure a safe margin and prevent the possibility of live steam entering the main supply while the exhaust is going through the roof.

Great care should be used to purchase high-class reducing valves and back-pressure valves because of the waste which would result if they did not work in harmony.

The supply main, then, contains steam at a fixed pressure, and if the system is properly installed, the pressure should not exceed ¼ lb. gage pressure. It could be worked below this on systems where oil separators are drained by vacuum pump. We connect all radiators, coils, and blast coils and all other low-pressure heating surface to this supply main in the ordinary manner with valves on each. The low point of each radiator and coils and all points where supply mains are drained, should be fitted with the highest type of automatic vacuum valves which can be secured. This valve will drain all water of condensation and vent all air to a vacuum return main, but must not allow steam to pass to the return line under any circumstances. Great care should be shown in choosing this device as the best is hardly good enough. All the vacuum valves are connected into a vacuum return main running back to vacuum pump in power house.

Usually a vacuum of from 5 to 10 in. (mercury column) is carried by the pump and this vacuum extends clear through the return line to the seat of each vacuum valve.

You should choose a valve with large area of ports and a valve that has a straightway or not more than one change of direction in the passage of water through it and valve should also have renewable discs and seats.

The water and air which is drawn from the radiation to the vacuum pump discharges to an air separating chamber which is usually built of large size pipe extending vertically from the stand pipe, the height of which is carried about 10 ft. above the level of the water in the feed water heater or receiver. This stand pipe liberates the air from the water, the air being discharged through a small vent pipe at the top of the stand pipe, to the atmosphere, while the water gravitates to the feed water heater or received and thus becomes available for boiler feed purposes. In such systems great care should be exercised to separate the oil from exhaust steam before the steam enters the heating main by means of oil separators properly equipped with oil traps, etc.

The above description is what is commonly understood as the return line vacuum system of today, but I take this opportunity to call your attention to a compound system of vacuum heating.

First, I call your attention to the fact that you gain by compounding a steam engine. You make better use of the steam and its expansive power by letting it work in 2 stages after pushing the piston in the high-pressure cylinder, going to the low-pressure cylinder and doing work there.

Here is the same principle applied to a radiator, compound radiation, in which exhaust or live steam passes through 2 heating chambers and gives additional radiating value beyond the simple vacuum system or what I have above described as the return line vacuum system.

The re-evaporation from the hot water of condensation can be used in an independent heat unit of radiation to increase the steam economy of the simple system, hence it derives its name from the twice over principle of Simonds compound system.

With this method, the radiation is divided into 2 sections, the primary and the secondary. The primary section is connected to the direct steam supply and has the vacuum valve on return from it, similarly to the simple system; instead, however, of discharging from the vacuum valve direct to the return line, this valve discharges the hot water into the secondary section, which is under the same partial vacuum as the return lines, and is really part of them.

In a simple vacuum system the water of condensation condensed in a radiator under atmospheric pressure, has a temperature of 212 deg. F. At this heat in a compound system, the water discharged into the secondary section will in part re-evaporate and such vapor will heat the secondary radiation. Under the ordinary conditions of compounding, water will evaporate in the secondary unit of radiation at 190 to 193 deg., when the vacuum pump is producing 8 to 10 in. of vacuum in secondary radiation.

Further, this vapor being condensed in the secondary, will pass to the vacuum pump as solid water, and no injection water being required in the condenser, will have a higher temperature when re-entering the boiler than possible with the simple system and its complementary cold injection water in the condenser.

Under this compounding system, the steam mains, risers and feeders can be much smaller than possible in any other system, reducing installation cost.

From practical demonstration in buildings it has been ascertained that when operating under a pressure in direct steam main of atmosphere or ¼ lb. pressure above, and 8 to 10 in. of vacuum in returns, the secondary cast-iron radiator may be one-half as large as the primary, and secondary unit will be fully filled with vapor at 190 deg.

Keep records of every detail of your operating costs, show it to the boss, have him feel that you are interested, then he will listen to you when you want the plant improved to meet existing conditions and to adjust proportions.

Boiler Hints

AMONG the suggestions for securing more satisfactory operation of a power plant, the following will be found helpful. Do not assume that the weight of coal as unloaded in your plant is the same as the car weight at the mine. Weighing the coal on delivery will give you a good check, both on the weight furnished by the coal dealer, and the coal used from consumption record.

Remember that the cheapest coal is that which gives the greatest amount of heat per dollar, and that record should be kept of the ash, so that if you have occasion to question the quality of the coal, you will have some basis for your complaint.

For best results in hand stoking, don't use a shovel that is either too large or too small, and don't cover the whole of the grate at once. Run the feed pump or condenser as continuously as possible, and fire as regularly as possible.

Test out the gage cocks and blow down the gage glass every day, and when putting in a new gage, open the lower cock first and heat the glass gradually.

Be sure, by frequent tests, that the safety valve and the pressure gage are correct and in good working order.

When banking, let the steam pressure drop a little and raise the water level somewhat higher than normal; be sure that the damper and fire are in such condition that the pressure will not increase during the night. Also, be sure that the blowoff cock is closed, and that all steam and feed valves are shut.

When blowing down for cleaning, which should be done at rather frequent intervals, let the steam pressure fall considerably before beginning to blow off water, and empty the boiler gradually, keeping the furnace doors and damper closed, to retain the heat in the flues, thus avoiding too sudden contraction. Also, the gage cocks should be open to admit air.

When putting a boiler in service, raise steam slowly, and when cutting in steam on cold pipe, admit slowly. Be sure that before boilers are cut in together, the pressures are equalized.

When refilling boilers, remember that the air must be allowed to escape, that gage cocks or other vents should be open, and the water filled in slowly.

If a boiler has just been started up, remember that there is considerable air mixed with the steam, and blow steam into the atmosphere for a short time before cutting in on a condensing engine; otherwise the air may be more than the condenser air pump can take care of, and the vacuum may fall off.

Test the working of feed pumps and injectors, both regular and spare, from time to time, so that, if called upon at short notice, you can depend upon them to do the proper work.

Remember that a counter on the feed pump will give you a reasonably good indication of the amount of steam generated, and this checked against the coal weight will give you a somewhat approximate but regular check as to the evaporative performance of your furnace and boiler.

Economical Way of Handling Ashes

SHOULD the boiler room be so located that you have trouble in getting out the ashes, the accompanying illustration will aid your engineer. The pipe beyond the ashbox can be set at any angle up to 45 deg. and can be any ordinary length. Clinkers must be broken up. Five minutes' time twice a day will get rid of all ashes made in 24 hr. Ashes should be blown into a closed ashhouse to avoid dust.—The Canadian Manufacturer.

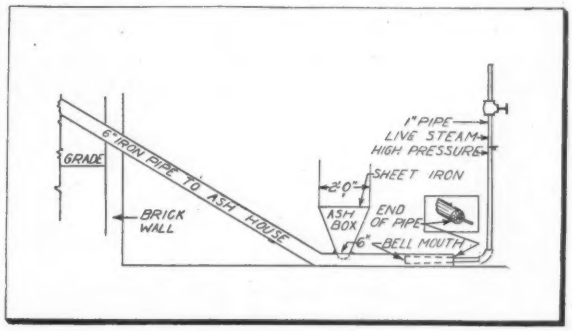


DIAGRAM OF ASH HANDLING DEVICE

THE TWENTY-SIXTH ANNUAL CONVENTION of the American Boiler Manufacturers' Association will be held in New York City, Sept. 1-4, with headquarters at the Waldorf-Astoria Hotel. All manufacturers of boilers, tanks and stacks, fabricators of steel plate, and manufacturers and their representatives of materials and supplies used by boiler manufacturers, are invited to attend. It is hoped that some action will be taken on the subject of uniform boiler specifications, which will come up for thorough discussion. Those anticipating attending the convention can have arrangements made for their stop during the convention by communicating with F. B. Slocum, Secretary, West and Calyer Sts., Brooklyn, N. Y., or any of the members of the New York Publicity Committee following: H. R. Cobleigh, Chairman, 10th Ave. and 36th St.; Geo. H. Partridge, 119 W. 40th St.; J. M. Lloyd, 239 W. 39th St.; Watson S. Anthony, Mgr., 120 W. 32nd St.; Geo. Slate, 17 Battery Place; all of New York City.

Direct Expansion System

ARRANGEMENT OF PIPING; OPERATION OF SYSTEM. BY A. G. SOLOMON

IN the process of refrigeration of coolers, freezers and other chill rooms, there are 2 distinct methods used: the direct expansion system and the brine system. First in importance is the direct expansion system as it is used in packing houses, breweries and cold storage warehouses. There are several different arrangements of the piping, and we will first look into the most common and simple form. As the name implies, the ammonia is expanded directly into coils placed in the rooms to be cooled or in communication with them by means of air ducts and shafts. Some rooms have the coils hung on the walls and ceiling; in some, the coils are placed in what is commonly called the pipe deck, while others have the coils arranged in banks and a circulating fan is used to circulate the warm air from the chill rooms through the banks of coils and back to the chill room. This latter system is more troublesome than the others and the rapid circulation of air has a somewhat drying effect on the produce to be cooled.

When cellars or other rooms do not require a very low temperature, the usual practice is to have the direct expansion piping around the walls, on the ceiling or on the posts such as are found in large rooms for supports

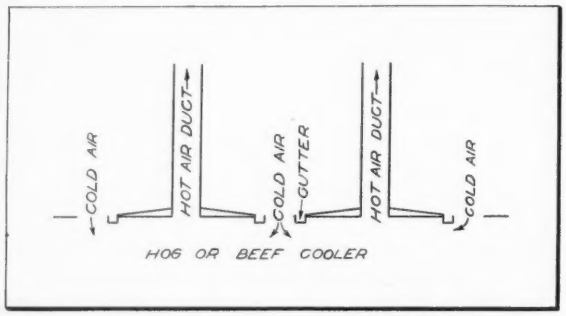


FIG. 1. AIR DUCTS IN PIPE DECK

of the floor above. Galvanized iron troughs are arranged under the coils to take care of the water when the frost is allowed to melt. In rooms of this kind the variation of temperature in different parts is quite great, being 5 or 6 deg. in some places. The coils are kept free of heavy frost or ice by using different coils and allowing some to remain shut off till clean and then using the clean ones and shutting off the heaviest coated. This works all right in rooms kept not below 32 deg. and where enough separate coils are installed to alternate their use.

The next style in common use is that in which a pipe deck or loft is used to contain the coils and air ducts are so arranged that the difference in temperature causes circulation. The floor of this pipe deck must be made water-tight and sloped so that the water which falls from the melting frost will flow into suitable gutters and to the sewer. Care must be taken that these gutters and sewers do not become frozen. To prevent this freezing, it is a good idea to throw a small amount of salt on the floor of the pipe deck during such times as the temperature is not allowed to remain above 32 deg. long enough to get rid of the water. During the winter months in a cold climate, this freezing often becomes a serious matter and at times water will overflow into the rooms below.

We will take one hog or beef chill room for example and follow the workings of it. First comes the arrangement of the piping and air ducts. The sketch shows a pipe deck having 8 separate coils each having an expansion valve and each set of 2 having a master liquid valve, suction valve and pump-out valve. By this arrangement, the ammonia for each coil is controlled separately by the expansion valves. As these valves are handled very often, they soon leak, and by closing the master valve and the suction valve and opening the pump-out valve into the auxiliary suction header, 2 coils can be pumped clear of ammonia and the expansion valves replaced, repaired or packed as the case might be. While this work is in progress the other 6 coils can be operated as usual. If, on the other hand, each coil was handled by an expansion valve connected directly into the liquid line, the whole room would have to be shut off while one valve was being repaired.

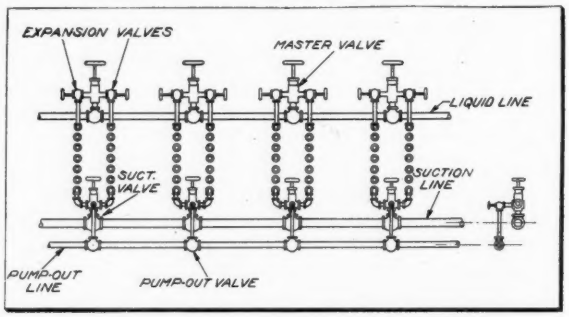


FIG. 2. COILS AND VALVES IN PIPE DECK

This is as good and simple a plan for this style of direct expansion piping as can be installed. Each expansion valve can take care of from 1600 to 2000 lineal feet of 2-in. pipe. Common wrought iron pipe is used for the coils and the flanges are put on with litharge and glycerin or can be sweated if desired. The ½-in. pipe connecting the expansion valve to the coil should be extra heavy. This piping is never called on to stand high pressure, so when testing a pressure of 100 lb. air is sufficient.

The ducts are of 2 kinds; the cold air ducts are level with the pipe deck floor and the hot air ducts are built up so that the top is even with the top of the coils. Both kinds extend the full length of the room. The floor slopes from the hot air to the cold air ducts and the gutters are at the lowest point.

Now, when the hogs or beef hanging in the room below, are sufficiently chilled and about to be taken out, all the expansion valves are shut off. The coils will likely all be heavily frosted. When the chill room is

again filled with fresh meat, the temperature will rise and all the frost will melt and the water be carried off. When the room is full and closed up, the coils will all be clean. For good results, it is best to start with only 2 coils and allow the moisture to settle on them first. When they become heavily frosted, as they will in a very short time, owing to the great amount of moisture in the air and also to the rapidity with which the ammonia can be evaporated in them, they must be shut off and 2 or 4 of the others turned on. The 2 that were first used will melt off quickly, as the temperature is still rather high, and the frost is of a soft and flaky nature.

The coils that now become frosted should be watched closely and if the temperature of the room and the length of time for chilling will allow, they should be melted clean again while the other 4 clean ones are being used. By careful handling and close attention the operator can nearly always have at least one coil entirely free from frost when the room is down to a temperature close to what is required. The clean coils are the ones that count and if all the coils are turned on at the start the temperature will drop very quickly for a while, but soon the insulating effect of the frost will begin to show itself and the thermometer will hang at one point or at best come down very slowly. Another reason for not putting on all the coils at once is that it will take a great amount of ammonia to supply them, owing to the heat of the room, and this will probably rob some other coils which should be kept going; also, the outside of the hogs or beef will be chilled before the animal heat is entirely out of the inside.

Quickness of the cooling is, as a rule, not left to the judgment of the engine room department and this, of course, must be taken into consideration when the number of coils are turned on. I have seen times when men have stayed in the pipe decks all night and swept the frost from the coils so as to get the required temperature by morning. As I have done this more than once I have had plenty of practical demonstration of the insulating effect of a thick coating of even a light loose frost. The cleaner you keep the coils, the better in every way. A frosted coil even in a 40-deg. room will not evaporate near so much ammonia as a clean one will. This fact can be easily seen when it is noticed how the expansion valve will have to be closed a little at a time as the frost gets thicker. The closer that the ammonia gets to the warm atmosphere, the greater the evaporation and therefore the greater the amount of heat taken up.

When there are several rooms piped in this way, suitable liquid valves should be placed in the liquid line so that, in case of accident, the whole number of rooms will not be put out of commission. When the system is shy on ammonia or when permanent gases are present, it will be easily noticed by the working of the expansion valves. The number of coils used at one time, especially when the rooms are hot, is often regulated by the amount of ammonia. It will be seen, that after a certain number of expansion valves have been opened, the next one will blow gas and will not produce frost on the coil unless opened much more than the others. When this condition is noticed, the best thing to do is to shut off 2 or 3 valves and wait till the ammonia has time to get back to the condenser. Trying to do work with gas is only throwing fuel away. One coil working properly with good liquid is better than 2 working half gas and half liquid. Everything sent through the expansion valves has to be handled by the compressor, so do not send anything to the machine that has not done work by absorbing its full share of heat.

The hot air from the chill rooms will travel up through the hot air ducts and the cold air will go down through the cold air ducts. This can be easily seen in a pipe check. When the steam-like moisture has settled on the coils and the atmosphere in the pipe deck is clear, a regular fog can be seen leaving the coils and dropping to the floor and then down through the cold air ducts to the room below.

Next in common use is the fan circulating system. In this style the direct expansion coils are usually built in banks and from 3 to 6 banks for each section that one fan handles. These banks are made up of single lengths of pipe connected at both ends with return bends. For example: a bank containing 1600 ft. of pipe will consist of 80 lengths 20 ft. long and built 10 pipes high and 8 pipes wide. Each bank will have an expansion, suction and pump out valve and each section should have main valves on liquid, suction and auxiliary lines.

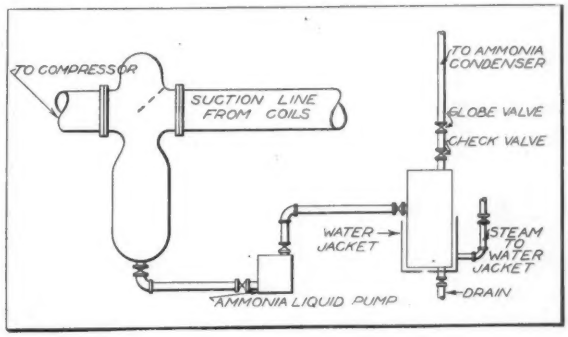


FIG. 3. ACCUMULATOR CONNECTIONS

The coils and fans are installed on the top floor of the building to be cooled and air shafts are constructed to the different rooms. The coils can be kept in operation all the time, as well as the fan, and the cold air directed wherever needed by means of the shutters, which are placed in both inlet and outlet air shafts from each room.

These shutters or doors are provided with an arrangement so that they can be fastened open any distance required. Do not let the banks of coils become heavily coated with ice, as it interferes with the air circulation to the fan as well as with the efficient work of the ammonia; it is also an extremely difficult job to get the ice off, for the pipes are placed on close centers both ways.

Provision must also be made to change the air once a week or whenever necessary, as the same air used too long becomes impure. Changing the air requires only a few minutes for each room and is accomplished by having a suitable opening to the suction of the fan from the outside air and a discharge from the room to the outside, also. These atmospheric openings can be best handled by having them open from the coil room.

In some places calcium pans are placed over the coils and the moisture taken up in this way will keep the coils free from frost as well as purify the circulated air.

The foregoing arrangements are for the use of cellars and coolers mostly where a very low temperature is not required or where plenty of time is allowed for the solid freezing of the produce. For the quick freezing of poultry and fish, what are termed quick or sharp freezers are used. These are, as a rule, rather small rooms and contain a large amount of pipe. The coils are built so as to form shelves on which the material to be frozen is placed in boxes or trays. The arrangement is somewhat similar to the bank coils of the fan system, only that the vertical return bends are longer so as to space the shelves the proper distance apart. In common practice, the room is long and just wide enough to con-

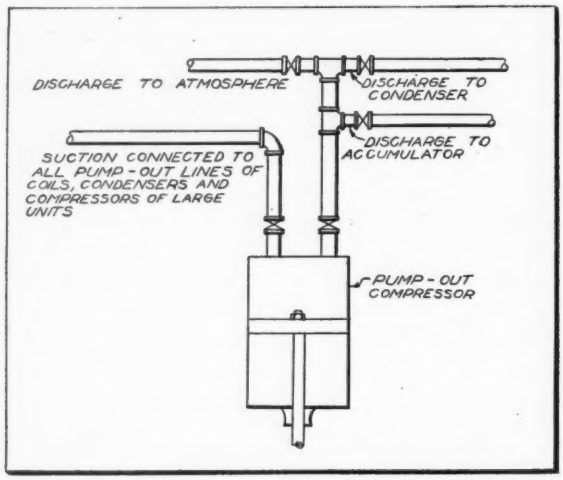

DISCHARGE TO ATMOSPHERE
DISCHARGE TO CONDENSER
DISCHARGE TO ACCUMULATOR
SUCTION CONNECTED TO ALL PUMP-OUT LINES OF COILS, CONDENSERS AND COMPRESSORS OF LARGE UNITS
PUMP-OUT COMPRESSOR

FIG. 4. PUMP-OUT COMPRESSOR AND CONNECTIONS

tain a set of shelf coils on each side of the central passage, which is just wide enough to admit of a truck passing. A much larger amount of pipe is allowed for each expansion valve in the sharp freezers than for ordinary chill rooms.

The quick freezers are kept at a temperature as low as 25 deg. below zero and the evaporation of ammonia is slow, so that when the coils are short, the liquid will pass through and not have time to evaporate. From 2000 to 3000 lineal feet of 2-in. pipe is common allowance for each expansion valve. Frost does not play much of a part in this type of freezer, as the produce frozen is generally chilled before going in and there is little moisture to collect on the coils. The frost that does collect will be light and dry and can be easily swept off with a broom.

In operating sharp freezers, the back pressure on the compressor must necessarily be kept as low as possible and there are a lot of ice machines that run on as low as 10 in. vacuum. This has been explained as necessary where the freezer rooms are at a great distance from the compressors. In such cases care must be taken not to get air into the system through leaks in the low-pressure side or through the packing of the ammonia compressor rod.

In one plant, we had several rooms that required a constant temperature of 20 deg. below zero and it was almost impossible to maintain it. One minute the compressor would be ready to burn up for lack of vapor coming back; the next, it would get a slug of liquid which would almost knock the heads out. We couldn't get the expansion valves set just right, no matter how we tried.

We tried everything and we were not lazy, but were perfectly willing to be on our feet every second if we could only get results. Sometimes those rooms would drop to 24 or 25 deg. below zero and then, seemingly without cause, they would go up 5 or 6 points in half an hour.

After doing everything imaginable, this is the final solution we hit on. The expansion valves could not be operated continually, as too much liquid would collect in the coils, no matter how close we adjusted them. The rooms were so cold that the exchange of heat allowed liquid to pass the full length of the coil without evaporating. We now opened half of the expansion valves as little as we possibly could and left them that way for about half an hour. Then we shut them off and opened the others for the same length of time, and then we left them all shut tight for an hour or sometimes less, according to the way the compressor behaved. This manner of handling freezers kept us pretty busy, but we did get results and we were satisfied. The coils to which I have reference were practically without a covering of frost at the end of a summer season and had been swept only twice. There were about 2500 ft. of 2-in. pipe to each expansion valve.

In some parts of cold storage work, as in egg rooms, the coils are hung on the walls and wooden curtains built over them. These curtains have sliding doors which can be raised or lowered as desired. Small fans are placed in different parts of the room to keep the temperature even in all places. Lime is used on the floor to take up moisture, as also are pans containing calcium. The calcium pans are generally set in front of the fans.

In any plant having a large amount of direct expansion piping proper traps and accumulators should be provided. Scale is constantly being loosened in the coils and if not caught will cause leaky compressor valves and pistons. Scale traps, especially those with screens, should be cleaned often.

In a large installation, accumulators are necessary on the suction lines close to the ammonia compressors. An ammonia liquid pump is also often used; this takes its suction from the bottom of the accumulators and discharges into driers or purifiers. The liquid and oil that is put into the driers is heated by means of steam coils or a steam heated water jacket to such a temperature that the liberated gas passes off into the condenser or into a set of cooling coils and then to the compressor. This arrangement will keep the heavy liquid from going to the compressors and will also be a means of eliminating dead liquid and oil. The dead and heavy liquid and oil is drawn off at the bottom of the purifiers at regular intervals.

Another thing which should be provided in an installation, where large units are used, is a small compressor for pumping out different coils for repairing

and removing oil. The loss would be great if a large machine had to be taken off the regular system to pump out coils.

Have a separate compressor for the pumping out work and also have cross connections made so that any of the large units can be used if necessary. The small pump-out machine can also be used to pump out the large compressors when needed for such reasons as packing the rods or examining valves or cylinder.

This smaller unit should be so piped on the suction side that all parts of the whole system can be reached. The discharge side should be piped so that the compressor can discharge into its own condenser or to the accumulators and purifiers of the large units and also to the outside atmosphere. In case of a bad leak in any part of the system, the discharge can be turned into the condenser or accumulators till atmospheric pressure is reached and then turned into the atmosphere so that air will not be pulled in at the leak and put into the system. Sometimes some repair work has to be done on some part of the piping and the valves leak so that the men cannot work on account of the ammonia fumes. In such cases, the pump-out machine can be kept going slowly and discharge the air and gas to the atmosphere and in that way keep all smell away from the place where the work is being done. Or if a coil that contains a lot of oil or dirt is pumped out, the discharge is turned into the accumulator and goes from there to the purifiers.

When a pump-out machine is used, it is a good plan to blow the permanent gases from its condenser as often as possible. Another good use for this small unit is to pick out those coils that are heavily frosted and pull a vacuum of about 15 or 20 in. on them 2 or 3 times a year. Large quantities of oil and liquid will lie in these coils and a good vacuum is the only way to get it out. Keep everlastingly at the coils and keep them clean on the inside as well as free from ice on the outside. Results can be gotten in that way, but in no other.

Whether the top or bottom feed of ammonia into direct expansion coils is best depends on the individual place and the conditions. Both work equally well when properly handled and taken care of.

Inexpensive Ice Plant

By A. L. Mitchell

READERS of Practical Engineer may be interested to hear of what I believe is the cheapest ice plant in the South, also to know that a plant can be installed and operated economically without having all the most modern appliances on the market.

Up to a few months ago, we bought ice from a local plant, at 40 cents per 100 lb. to the company and 60 cents to employes. As we have some 700 men on the payroll, and use about a ton of ice a day around the plant, the bill amounted to something. I tried to impress the owners of this plant with the fact that we could put in a small ice plant and save money, but they were unwilling to go to much expense. They told me, however, if I could find something cheap, to go ahead.

I heard about a 3-ton machine which had been out of commission for 2 yr., and was for sale in a small town in Louisiana, and going there, cleaned away a lot of cinders and mill refuse and discovered a small, 7 by 12-in. Triumph compressor, with the disk broken off the crank, the rod worn, and the whole machine badly rusted. The brine tank had several dozen rivets badly corroded, but the sheets were in fair condition, and the cans, some 80 in number, were fair. Can dump, crane and condenser were badly rusted, but with a little cleaning up, were good for several seasons.

Being told by the owners of this scrap to name my own price and take the stuff away, I told them that I would give them $200 for the complete plant, f.o.b. their cars; they gladly consented, and the men were at work tearing down and loading before I left that evening. When the stuff arrived, I had a new crank disk and pin made in our shops, also turned up the rod, bushed the stuffing box and gland, ground in the valves, put new rings in the piston, and cleaned everything thoroughly. We installed the machine and tank in our power house, so that the engineer could also look after the machine, thus saving one man's time.

As we had no steam condenser, nor distilled water cooler, I looked around to see what could be found for that purpose, and discovered an old 20-hp. upright boiler on the lot, which was given a good cleaning and then converted into a steam condenser, which, I must say, is a dandy. The boiler was turned upside down on a pan to catch the water, then the exhaust steam piped into the blowoff, which was now at the top of the boiler, and the condensed water from the bottom piped to the reboiler. The cooling water came from the ammonia condenser, and was piped into the fire box running down through the flues, thus condensing the water perfectly. I found an old enclosed heater in the scrap, which had a good copper coil in it, and this was converted into a distilled water cooler by piping water from the reboiler into the top of the copper coil and out at the bottom. Cooling water was piped into the shell at the bottom, and overflowed at the top.

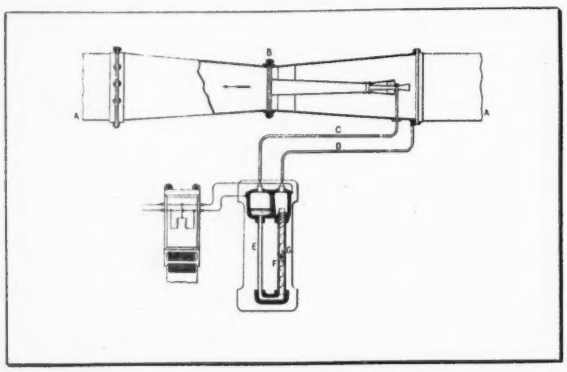
My distilled water regulator was made of a few old cocks and fittings, and an old water bucket. The plant was started up 2 months ago, and has run to date without a minute's stop, making from 3.5 to 4 tons of ice a day, as good and clear as any on the market. The entire plant, from start to finish, including freight and the first charge of ammonia and salt for brine, cost $600. If any reader knows of anything cheaper than this, please let us hear from him, so that I can take down my sign. It costs $3 a day to run the plant and deliver the ice.

Secondary metals, or those recovered from scrap, sweepings, skimmings, etc., amount to a considerable item in the year's product. From the report of the Geological Survey, the value of such recovered metal from waste and scrap in the year 1913 was $73,000,000, including copper, brass, lead, zinc, tin, antimony and aluminum. After remelting, or refining, these secondary metals, which sell at a price slightly lower than new metal, are available for most purposes where new metal would be used. The copper recovered amounted to nearly 140,000 tons, the lead to nearly 73,000 tons, spelter to something over 79,000 tons, tin, 14,000 tons, and aluminum, 2500 tons.

Foreign Development in the Power Plant Field

ELECTRICAL APPARATUS FOR MEASURING THE DISCHARGE OF STEAM; EFFECT OF DEFORMATION ON STEEL; MAGNETIC PROPERTIES OF CAST IRON. BY J. H. BLAKEY

AT the annual exposition of the Society of Physics, held in Paris in April, there was shown, among a number of other scientific novelties, an ingenious device for measuring the discharge of steam or other gas. The apparatus is manufactured by the firm of Carpentier, of Paris. It is, as will be seen by the figure, an application of the principle of the Venturi meter, with a multiplying attachment by which, it is claimed, very accurate results can be obtained. At the throat, B, of the outer tube, is placed the mouth of a second tube, similar in every respect to the first, but much smaller. This smaller tube also encloses another, smaller still. With the dimension of the particular appliance exhibited, this device multiplies the difference of pressure at A and at B by 25; consequently, if a tube from the mouth of the large Venturi, and another from the throat of the smallest Venturi, are connected to the 2 arms of a manometer, it will be seen that a considerable difference of pressure will be obtained.



APPARATUS FOR MEASURING DISCHARGE OF STEAM

The manometer is filled with a conducting liquid, usually mercury, and in the arm, F, is arranged an electric conductor, G, whose resistance varies according to the extent of the immersion in the mercury. This conductor may be straight, of varying section, or it may be of spiral form, with pitch increasing in regular increments from the upper to the lower end. The upper end of the conductor and the mercury in the other arm of the manometer are now connected to a measuring apparatus, such as a proportional deviation ohmmeter, by means of which the difference of pressure can be read with a high degree of accuracy.

FRAGILITY PRODUCED IN STEEL BY DEFORMATION AT DIFFERENT TEMPERATURES

AT THE meeting of the French Academy of Sciences held at Paris on Feb. 2, M. Georges Charpy presented a note giving the results of experiments made by him on the fragility of steel after deformation by hammering at different temperatures. In the following table the figures indicate the number of kilograms which were required to break the test piece in the particular form of testing machine used, first without any deformation, and later after deformation by hammering at the given temperatures.

	Soft Steels				Nickel Steels	
	A	B	C	D	2%	6%
No Deformation	44.5	40.0	43.5	26.9	36.0	29.1
15 deg. C.	38.3	23.9	25.4	1.5	34.3	20.4
150 deg. C.	38.3	23.9	25.4	1.5	35.3	20.4
200 deg. C.	40.4	20.6	12.2	0.5	33.8	17.8
Deformation at—Deg. C.						
225	41.1	20.6	12.2	0.5	29.5	14.6
250	39.4	17.0	4.8	0.5	30.5	15.1
275	37.3	17.0	4.8	0.5	34.4	13.7
300	40.4	19.4	6.2	0.5	31.5	18.5
400	41.5	25.2	10.9	0.5	35.3	28.5

The facts of importance to manufacturers and users of steel, to be deduced from this table are, that the increase of fragility produced in steel by hammering takes very different values according to the nature of the steel used, and secondly, that from 250 to 275 deg. is a critical temperature at which deformation should be avoided. Similarly, this temperature may be used as a means of eliminating dangerous steels, for a steel which is satisfactory after deformation at this temperature, may be hammered at any temperature without increasing its fragility to the danger point.

MAGNETIC PROPERTIES OF CAST IRON

PROGRESS MADE within the past few years in the metallurgy of iron has made it possible to produce soft steels superior, from the magnetic point of view, to the purest puddled iron. These steels have, however, as far as concerns their utilization in the construction of electrical machines, the disadvantage of being difficult to work when they are required to take complex shapes; moreover, they are costly in comparison with cast iron. The latter, being easy to mold and machine, would be an ideal metal for electrical purposes if it were more permeable to the magnetic lines of force, if it became saturated less rapidly and if its specific coefficient of induction were higher when it is saturated.

In Stahl und Eisen, M. Gumlich gives an account of experiments which he has made for the purpose of improving the magnetic qualities of cast iron. He has studied successively the effect produced by the various components of the casting, and has found that it is especially necessary to reduce as much as possible the proportions of carbon and manganese. Carbon forms with iron a number of combinations, such as pearlite, cementite (Fe_3C) and martensite ($Fe_{24}C$), which are all more or less impermeable, and the manganese has the effect of reducing the permeability of the iron, as its own peculiar property, as well as favoring the absorption of the carbon. Silicon, which on the other hand, favors the precipitation of the carbon, can be present in moderate quantities; also, slow cooling, which gives this precipitation time to complete itself, is equally advantageous.

For the manufacture of permanent magnets, on the contrary, the author indicates the following as the best composition of the casting: Carbon, 2 per cent at the most; manganese, 1 to 2 per cent, and as little silicon as possible.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Stoppage Curve of Reciprocating Engine

NOT LONG ago, in conversing with a man who tests large steam turbines for a prominent manufacturer, I was told that it sometimes takes more than an hour for the rotor of a well-balanced, nicely-adjusted steam turbine to come to rest after the steam has been cut off. Readings of the speed are taken at frequent intervals during this stoppage, and, I was told, the form of stoppage curve is about like that shown in Fig. 1. He did not give me actual figures, so I cannot plot the curve accurately.

This made me ponder somewhat over the possible stoppage curve of a reciprocating engine, and I decided that the best way to find out was to try it on an actual engine, which I did on a 15-hp. gasoline engine, the results of which are shown in Fig. 2. The "curve," you will notice, is virtually a straight line.

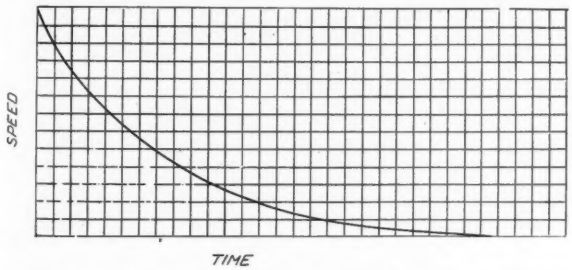


FIG. 1. FORM OF A SPEED-TIME CURVE OF A STOPPING TURBINE

I had no chronometer for counting the speed accurately; but, as you will note, I got results just the same and used nothing but my fingers and a watch. I held my finger close to the flywheel shaft, permitting the key to touch the finger at each revolution. This finger was on my left hand. I occupied my right hand by putting down a dot on a piece of paper every time my left-hand finger was touched. Thus, for the first 5 sec., I made a series of dots—20 of them—in a horizontal line. During the next 5 sec. I recorded 17 dots on a line just below the first; during the next 5 sec., the number of dots (or revolutions) was 16, and so on, as plotted in Fig. 2.

This, in my mind, tends to prove that the retarding force acting on reciprocating parts is constant; whereas, in purely rotating parts, the retarding force is not constant. Perhaps the difference in the appearance of the curves is due to the difference in speeds. Windage, in a turbine rotor, would be pretty high at high speeds. The retarding force on a reciprocating engine, due to windage, would not be so great.

N. G. NEAR.

The Why of Examiners' Questions

MR. PIERCE, in the issue of July 1, expounds a rather pessimistic view of the relations between engineers and examiners. It's war, anyway, he thinks, and "War is Hell." Without doubt, some examiners are not what they should be; without doubt, all of them make mistakes at times. But they are not a bad lot by a long shot, and it is hard to imagine what basis Mr. Pierce can have for his closing paragraph.

Suppose we put ourselves for a moment in the examiner's place. What would we do? In comes John Jones, applicant for engineer's license. We look over his application. Say it shows a lot of experience. We wonder at once why he hasn't already secured this license. Or is he running the risk of perjury conviction by "padding lists"? Or, say the experience shown is meager, then we must go carefully through many points before

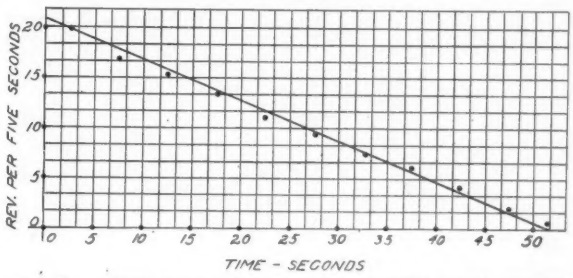


FIG. 2. SPEED-TIME CURVE OF A RECIPROCATING ENGINE

we can grant a license. The way the application is filled out, we must take into account the intelligence shown or lack of it. Mr. Jones is, let us say, a good intelligent appearing fellow—so are gold brick men. He may have some good recommendations; that signifies nothing; some of the biggest dubs we ever saw had a valise full.

We are interested in one thing—is this man safe, is he fit? To be that, he must know what to do in certain emergencies. We will see whether he does. Better still, he must know how to avoid the things that bring emergencies. We will question him about oil in feed water, about care of governors and valve gears. But the work of the engineer grows and broadens. New apparatus comes, new emergencies arise; has this man the reasoning powers to meet these new conditions as they arise? Is he a student who will keep on growing after he gets his license, or simply let things slide? How much has he picked up from the plants where he has worked? Has he visited others, and what has he observed? We can't ask these questions directly, perhaps; but we will come at the subject in some way. Of one thing we must be on our guard. Certain schools prepare men for license examination by cramming them full of questions

and answers. We will try to find out from his manner of answering or in other ways whether Jones has got his learning there. If so, we know he is posted on answers to certain questions. We will frame a question calling for the same answer, but differently put. If he knows what he is talking about, we will pass him; if he is simply a parrot, we won't. If we let him off easily, men who know him will say "favoritism" or "graft." If we are hard on him, others will say worse things; but we must not think of that at all; we are here to protect the public.

Now, that seems to me a perfectly fair attitude, and I can testify that it was the attitude of those men who have examined me.

"Why is an engineer . . . compelled to know the tensile strength of various boiler steels?" asks Mr. Pierce.

Could a real engineer be ignorant of such matters as tensile strength, ductility, etc., of boiler steel? Would such a man be safe? The boiler inspector comes not over 4 times a year, spending in all, about an hour on each boiler. During the other 364 days and 23 hr., it is up to the engineer. He should actually inspect the boilers himself. He should check the inspector. Inspectors often overlook faults; let the engineer find them. Suppose the inspector cuts down the pressure. He may have made a mistake. The engineer should know, if such is the case. He may save his employer annoyance; this has actually been done. Or, suppose the inspector errs and puts the allowance too high; if the engineer knows, he can set the safety valve within safe limit. The engineer may not have to design boilers or to set them, but he should know whether they are correctly designed and set.

Then, as to governors, valve gears, etc., did Mr. Pierce ever see an engine run away? I saw such a thing once. It was a result of monkeying with a governor by a man who did not understand it. I saw another nearly create havoc because the engineer was ignorant of proper adjustment of the valve gear. No man can be expected to know all the ins and outs of every gear and governor; but he should know some familiarly and he should know the underlying principles well enough so that he can see through a new type quickly. I doubt whether any examiner ever asked more than that; and so much he has a right to require. If a man expects to get an unlimited license, he should possess a fairly broad knowledge of apparatus.

For Mr. Pierce's information, I would say that in Massachusetts, boiler inspectors are required to have a license, and it seems to be a just requirement. If any of the laws modeled after ours have omitted this provision, it would seem to be a mistake. Also, another of his "whys" falls to the ground; for here a man who can get a license to cover a 150-hp. engine is free to tackle anything as far as license goes. Nevertheless, we all know men who get by fairly well in a small plant, but who would soon make a mess of a larger one.

Mr. Pierce cites just one definite question in support of his contention against the examiners. This, however, strikes him as so "idiotic" as to seem to prove the whole case. Instead of being idiotic, I look upon that question as a perfectly legitimate one.

"If you were operating a boiler where there were no tools to be had and found a crack several inches long in the head, what would you do to make it as good as new, and as strong?"

Now, the way to do that job would be to weld it. The ancient method would have been to fill the crack with plugs, but we can do better now.

The examiner, however, may have cared little whether he got the right answer or not. Such a question gives the man who is putting up a bluff a good chance to blow himself, while it can't fool a good man. The examiner wants to know whether the man before him knows the difference between a good boiler maker and a bum. He does not expect the engineer to be a boiler maker; but he does require that he have knowledge and judgment enough in the matter to enable him to say whether a job is well done or not, that he shall know good methods. A question like that above is usually put in order to lead to conversation that will bring out what the applicant knows. If Mr. Pierce can find nothing worse than this question, I, for one, will have to give the examiner a clean slate.

WILLIAM E. DIXON.

Retubing Boilers

IN LOOKING over the article on Retubing Boilers, in the July 15 issue, I find 2 mistakes which might be misleading. The first is in regard to beading the ends of fire-tube boilers. The beading tool marked "B," Fig. 5, should be used first instead of the one marked "A." The reason is, that it is easier to hold on the end of the tube, and also that it will roll the end over better than the other tool which has a shorter lip, and is used to draw the end down in finishing, which could not be so well done by the other ("B") on account of the long lip.

The other mistake is in Fig. 6, which shows the right and wrong way of beading. The figure marked "right" is wrong and the one marked "wrong" is right. The end should be drawn down tight against the head. The reason for beading tubes is twofold: First, it gives greater staying power to the head to prevent pulling off the tubes; second, it prevents the end of the tube from becoming overheated. When the bead is drawn down tight to the head, it transmits the heat of the fire to the water much more readily, or, in other words, the end of the tube is kept cooler by the water. If the tube end is not beaded, or if improperly done, the end is not so protected and may become overheated and thereby weakened to such an extent that it will be pulled through the head.

Mr. Williams, in the same issue, gives a good idea of the proper way to use the ripper in cutting out tubes and nipples.

In the July 1 issue, one writer says that the tubes above the bottom row in a water-tube boiler should not be pulled through the tube hole, but that the tubes in the rows below it should be taken out to get to it. I submit that it is sometimes a tough proposition to get the tube out through the hole; but unless it is on, say, the second row, or the tubes below it are in bad condition, it would be too expensive, especially if it was on the fourth or fifth row. A 4-in. by 18-ft. tube, including the work of putting it in, will cost from $6 to $8, and for that reason I prefer to spend a little more time

getting the old one out. I have renewed a great many tubes, especially in Babcock & Wilcox, Heine and Stirling boilers, and although some of the seats have been badly scored I had little trouble in getting a tight joint. Take, for instance, the bottom row or second row in which the tubes have been frequently renewed, the hole becomes stretched from repeated rolling so that quite a large bag will pass through with a little pulling.

J. C. HAWKINS.

Comparison of Heaters

REFERRING to the article in June 15 issue of Practical Engineer entitled, Heating and Ventilating Large Buildings, we are taking the liberty of assuming that these articles are published with a view of getting any comments which the readers may have to make, and, therefore, are making a few statements, which are prompted by the writer's extended experience in this line.

We note that 2 types of heaters are shown, both of which are of the steam-tube type, wherein the steam passes through the tubes; also the statement that better results are to be had with the water-tube heater, than with the steam-tube type, which point is, without doubt, true. Modern practice demands that the water-tube heater be used, also that the tubes shall be made of pure copper or brass, preferably the former, and that the shells be of cast iron. It is also quite important that the tubes shall be of small diameter, approximately ¾ in.

We wish to say, further, that the use of the live steam heater in conjunction with the exhaust steam heater is rapidly becoming obsolete, because the first cost is increased, as are also the frictional losses when the live steam heater is called into use, and neither of these are warranted. It is also true that considerably more valuable space is required, and the cost of piping and pipe covering increased materially. Modern practice does away with the live steam heater, the live steam being introduced directly in the exhaust steam heater. This is the arrangement which has been followed in all of the newer factories of the National Quality Lamp Works, and substantially is the same arrangement as was followed in the Grand Central Terminal in New York City, whose heaters the writer designed.

As to the design of the heater, it is quite obvious that it is necessary, to obtain the best results, to use the heater which eliminates packed tubes, the reason being that the majority of hot water heating plants have a static and a frictional head between 50 and 100 lb., and continual expansion or contraction of tubes through packings will in a short time cause the packings to leak, even at pressures below 20 lb., so that it is not good judgment to use packings on higher pressures.

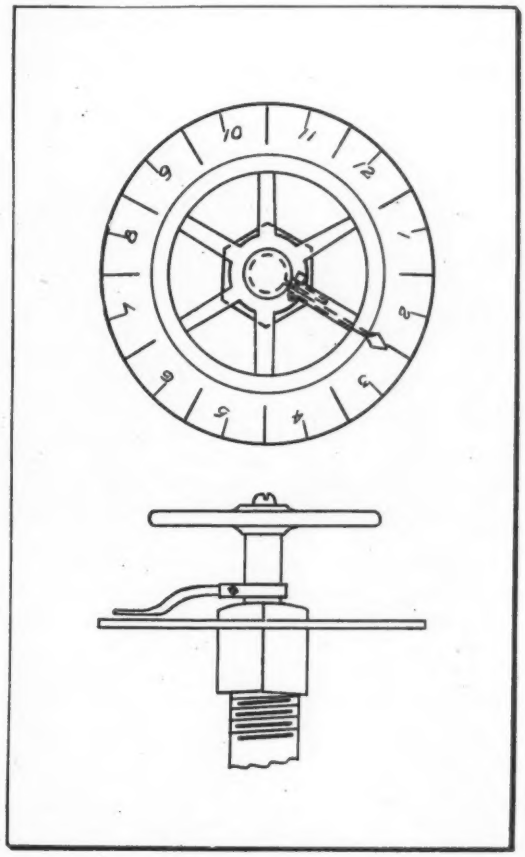
ALBERGER HEATER CO.,
S. C. ROSS.

Valve Regulator

ACCOMPANYING is a sketch of a pointer of brass and disc soldered to the nut of a globe valve stuffing box. The pointer is clamped to the valve stem, setting the pointer on 1 when the valve is closed. It is an easy matter to regulate the opening of the valve for allowing the gradual escape of steam or liquid.

I have used this on a boiler feed pump valve at the steam end for regulating the speed of the pump and I would not exchange for an automatic regulator under my present conditions.

When the stuffing must be drawn up or packed and the disc does not come back to the same place, loosen the screw in the pointer clamp and shift it to 1; when the valve is closed, then clamp the screw tight.



A HOME-MADE VALVE REGULATOR

Numbers can be stamped on the disc right or left-handed. I have never seen anything like this anywhere.

O. C. BEINEMAN.

Trouble With Suction Pipe

EVEN IF a pump is considered rather of secondary importance, especially if it is a small one, I have found in my experience that about as many things can happen to it to puzzle an engineer as to any other piece of machinery about the plant.

At one plant where I was employed, we had a 4 by 4 by 5-in. Worthington duplex pump with the suction pipe laid a distance of 250 ft. to the channel of the river. This river was dredged about 15 yr. ago and at that time the suction pipe extended out over the edge of the channel; but, as the years passed, the channel gradually filled in and the suction pipe became imbedded in the mud. This gave us a lot of trouble and, at low tide, the mud would have to be shoveled away. When the tide was high and it was impossible to reach the end of the

pipe, city water had to be used; but this was very unsatisfactory, both expensive and too low pressure.

To remedy the trouble, I first removed the foot-valve and put a screen in its place. I then tapped the suction pipe at the pump from the ¾-in. tube blower line. As there was no stop valve between the pump and suction pipe, I found that the valves and packing became heated; but opening the priming valve (city pressure), which was inside the connection for the steam, kept the valves and packing cool unless the pipe was plugged too hard, when the suction pipe had to be removed entirely and an iron plug placed in the end nearest the pump.

This arrangement proved to be satisfactory and we do not now have to use the city pressure at all; the suction pipe can be cleaned, no matter whether the tide is high or low. CHARLES RICHMOND.

Diesel Engine Information Wanted

JUDGING BY the amount of information on operation which one finds in the journals, it would seem that there is but one man in the entire country, and that one myself, who has any desire to advance himself and to benefit his fellow craftsmen in the operation of the Diesel engine. I believe that the oil engine is the coming prime mover and watch each paper closely for anything on the subject, especially practical hints from operators who tell how to find and overcome the little things which may be considered as everyday troubles.

Many different oil engines are now in service, and many more are being installed every day, but beyond the little that 1 or 2 of us have written, I have been unable to find anything from the operators.

One great defect among the engineering fraternity, which every engineer knows and which most of them do not try to remedy, is the apparent unwillingness of the class to stand together, and it would seem that each of us is afraid that he may benefit his fellow man by telling him something which will be for his professional good.

As regards the Diesel engine, it would seem that the operators are going to guard their precious little secrets even more closely than the points in regard to the operation of the steam engine have been guarded. One man remarked to me that in telling my few little experiences I was putting someone else in possession of facts that might come in the way of ousting me from my job, and I believe that is the reason the craft is so unwilling to "jar loose" any of its pet methods of operation. But, as far as I am personally concerned, I am not married to this or any other job, and since I was looking for a job when I got this one, why if the other fellow gets me out, I shall be where I was then, and perhaps he will be better off.

I know one set of fellows who vowed by the eternal gods that they would put in no time trying to find out anything in regard to these new-fangled notions in the field of prime movers. "No Sir! Not I!" And they made considerable sport of the writer for being on the anxious seat for fear that he hadn't brains enough to learn the Diesel type of engine. But now these same men are looking for information because their employers are installing Diesel engines and the writer has one of them for company all the time trying to learn in a month all that is possible to know about it. One peculiar fact is that one can secure little satisfaction from the factories regarding the operation of Diesel engines. It would seem that they make engines—not operate them, for several letters in the possession of the writer suggest that if he would try this or would try that, or do something else, it might help a little, and asking to let them know how these things tried, resulted. Of course, any one of their experts could come on the job and make a balky engine get busy, hence it must have been my ignorance in asking questions and that I did not know how to ask them properly. But there is no type of engine in existence, nor any engineer who does not have his daily troubles, and frequently of quite varied nature; so that if one knew how to recognize any particular trouble when it arises, or how to overcome it, he would be in much better way to hold down a good job.

In conclusion, let met again urge the Diesel operators to give up a little of the knowledge that each of them certainly must have so that we, the members who have it not, may benefit thereby. JOHN PIERCE.

Balancing a Steam Turbine

I NOTE that E. R. Pearce, in the July 1 issue of Practical Engineer, takes a kindly "swat" at me just because I happened to witness and write about a simple case of turbine balancing. That is exactly the reason why I told about it. It proves that often, where the average man would consider a job super-complex, it turns out to be decidedly elemental. Had the job been difficult, I doubt if I should have had the nerve to tackle telling about it. Hard things are doubly hard to describe. In balancing this turbine, no place other than the coupling was touched, to my knowledge. As for the exact weight of the plugs, I do not know. I merely guessed them to be about 2 lb. from their weight in handling.

Although I do not claim to be a turbine expert, I have served in slight designing capacity for a prominent manufacturer of turbines, and from that experience know some of the difficulties of obtaining perfect balance; since disks are usually balanced separately, I will admit that perhaps Mr. Pearce is right in inferring that the coupling was the out-of-balance part. I did not state what part was out of balance; I merely told what was done. The chances are, the engineer who did the balancing does not know to this day just what was wrong, nor does he care as long as the machine runs without vibrating.

I do not like to make things appear difficult if it is possible to make them appear simple. That is one of the troubles with which most of us have to contend. Many college professors, for instance, delight in it. I recall such a professor, a type of "deep lecturer," who commenced his "one-hour-straight" in about this fashion: "The modulus of elasticity of cast iron being widely variable with different grades of the metal, we find it difficult to develop a precise rational formula for the steam engine base which we are designing today, which is subject both to tensional and bending stresses. In fact, cast iron is not a strictly elastic metal, anyway; however, by plotting the modulus figure, by noting the

close approach of its outlines to the parabola, and by the application of a little simple calculus, we obtain this result . . .''

Thereupon he would cover the blackboard with figures, curves, unfathomable sketches of 3 dimensions, sometimes referring to even the fourth dimension to further entangle us, and with drawn features and wrinkled brow that certainly portrayed the mathematical depths he had reached, the professor smote out his lecture while we, who were quickly disinterested in the then dry subject, merely copied what he wrote on the blackboard and patiently waited for the hour to end. His method was to take us by surprise at the very beginning of his lecture and snow us under with a carefully wrought sentence just as a football team in the early stages of a game plays the opposing team off its feet if possible. After we were lost, the professor seemed content. He cared naught for himself or for us. When he saw that we were all stupefied, his wrinkles disappeared and his face lit up. If lectures could possibly be more droll, I am unable to conceive them.

That, then, is one of the reasons why I dislike to make simple principles obscure. Balancing, mathematically, is a simple process. It is my recollection that balancing is a matter of ''first moments'' only; i. e., force times distance. If we know the exact ''unbalancement'' of every rotating part, the correct balance weights are determined by simple arithmetic. Balance every disk and every rotating part separately, and, as Mr. Pearce says, the whole turbine, when assembled, should be in balance.

I will acknowledge, though, while steam turbines are the subject, that I have made mathematical errors and one in particular that makes me feel like a fool every time I think of it. While I was draftsman for the steam turbine company for which I worked, the chief draftsman once asked me to find the center of gravity of the assembled turbine rotor. He told me to do it graphically. I, however, didn't appreciate graphic methods in those days, thinking that they were not exact enough; so I chose the more laborious and more accurate mathematical moment process. I worked at the job for a whole day, using a slide rule for speed. I finally found the center of gravity, as I thought, and informed the chief. The chief came, looked at the point I had made to indicate the center of gravity, and had the impudence to tell me at once that I was wrong. He said it looked wrong, and instructed me to go over it again, this time using the graphical method. I spent another day at it (being sore, I purposely used more time than was necessary) and sure enough I got a different result just as the chief had predicted. Of course, I still believed my mathematics to be right; but, just to be sure, I checked both my mathematics and graphical methods over. I was wrong. The chief was right. And you can imagine that I had a hard time explaining to the chief the ''slip'' in my figures.

I can see now that I should have used the graphical method in the first place, as instructed. Instead, I wanted to show the chief that I was better than the average man, and that I could be depended on to handle ''complicated'' processes.

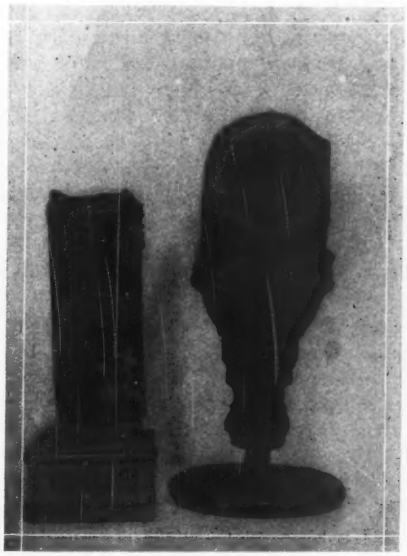
Ever since, and more and more, I favor simplicity. The simpler the better. I am therefore glad that I witnessed one of the simplest cases of unbalanced turbine. Had it been complicated, I don't think I would have dared to attempt to explain it, as I have already said, and this chance to air my views on simplicity and complexity would have been lost.

At any rate, Mr. Pearce admits that balancing requires judgment and experience, despite the experimental shift-and-try method; therein we all agree.

N. G. Near.

A Dangerous Pipe Condition

Recently, it was necessary to change a 1½-in. water line in our engine room, the line running from a large service line through a wall to the boiler room. As there was no union inside of the wall, the pipe was cut about 2 ft. from the valve. After the pipe was cut, a wrench was put on the short piece to screw it out; but, as the wrench was hung on the pipe, the wrench, short piece of pipe and valve all dropped to the floor, the valve coming off the nipple shown in the cut.



CONDITION OF VALVE AND PIPE WHEN REMOVED

This line was carrying 90 lb. pressure in the daytime and sometimes went above 100 lb. at night. Although the pipe showed rust next to the valve, it had not leaked any. If it had not been for the pipe's being firmly fastened in the wall, the pressure would have pushed it apart long before it was taken down.

L. M. Johnson.

The year 1913 broke all records for the amount of coal mined. More than 570,000,000 tons were taken out in the United States, the value being some $760,000,000. The increase over 1912 is nearly 7 per cent, the largest increase being bituminous coal in Pennsylvania. The combined production of that state for anthracite and bituminous was over 265,000,000 tons, or about 1/5 of the world's coal production.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Boiler and Engine Troubles

WHAT WOULD you do to a safety valve which blows at 75 lb. and continues doing so until the pressure falls to 50 lb.?

2. What care is necessary for a boiler which is to be cut out all summer?

3. Two boilers are fed by gravity. What is the cause of water going too high in one and too low in the other?

4. If you are feeding your boiler by means of traps located 40 ft. above and at a pressure of 15 lb., what kind and number of traps would be necessary?

How would you stop a pump pounding or striking its head with and without opening it? If opening its cushion valves, would you give it more or less compression?

6. How would you stop pounding in an engine?

7. What is the cause of, and how would you prevent an engine from racing? This trouble is indicated by the fluctuation of the lights.

CONSTANT READER.

A. Safety valves are like all other machines: no matter how much care is used in their construction, there is always a liability of the mechanism becoming corroded or otherwise injured, which renders it liable to sluggish operation. Sometimes if a boiler foams or is filled too full when blowing, the sediment drawn into the safety valve with the outflow of steam and water will cause friction in the guide of the disc, or fill the "blow back" arrangement so as to render it almost useless.

If the valve blows back as much as ⅓ of the working pressure before closing, take the first opportunity to take it apart and clean all parts of it. Look for bright spots on the guide flanges below the disc, and remove them with a "dead smooth" file. Grind the valve to a perfect seat with emery flour or ground glass.

Practically every pop valve has some device whereby the number of pounds it will "blow back" can be regulated. Usually in ordinary practice, pop valves are allowed to blow back from 1 to 3 lb. While some engineers permit as much as 5 lb., it is not good practice, besides being a waste of steam.

Not knowing the type of valve you have, I cannot advise definitely just how to proceed; but by a careful study of the mechanism, you can soon learn how. The maker of the valve will be only too glad to assist you in this matter, also.

2. Where a boiler is to be cut out for the summer, it must be carefully cleaned inside and out. If bad scale is prevalent, use an excessive quantity of compound and let the boiler stand a few days, and if necessary keep a light fire under it. This is a good time to burn up old rubbish and wood with spikes, or old iron attached which cannot be burned in regular operation for obvious reasons. When the boiler is dead, all this junk can be effectively removed from the grates.

If possible, do not empty the boiler when hot and especially so, if you intend to let it stand some time before cleaning it, as the heat will bake the scale on again, making the job more difficult than it otherwise would be.

Begin at the top of the boiler, removing all scale as you work down and remove it from the shell, and wash it out with a hose and (preferably) warm water, say, at about 125 deg. It is a good plan to put a convenient wooden plug in the blowoff pipe as it leaves the boiler shell, drum, or manifold, as the case might be, which prevents filling the pipe with scale. Leave it there until all of the scale has been removed through the manholes or other openings.

When clean, leave an opening at the top, such as a manhole, and a manhole or several handholes at the bottom; this will insure a good circulation of air through the boiler. See, however, that there is no steam or moisture that is liable to find its way through the boiler. If it is liable to do so, and cannot be stopped for any reason, the writer has seen a short return bend radiator set where convenient back of or in a boiler, and connected to take the exhaust of a small convenient pump or any other method that the circumstances might suggest.

Clean off all soot wherever located. Inspect all brick work and if necessary (and it usually is), patch up all little holes or leaks in the setting. There is more cold air passing through the average setting and cooling off the gases and boiler, than most people imagine.

Look over the grates and bearing bars, and repair or renew all parts that need it. In shaking grates, where pins have become worn, renew them and, if necessary, drill holes a small amount larger and use new pins to fit.

If the bridgewall or sidewalls need renewing, do not leave it until the last thing, but have it attended to at once. You may need the boiler some time in a hurry. It is best to lay the fire brick for 18 in. to 30 in. above the grate, in headers; that is, with the ends to the fire.

Look over the fire door baffle plates and renew or repair as required. If the hinges have worn so as to let the doors drop, ream out the holes with a taper reamer (preferred) or a drill of larger size and put in a larger hinge pin. See that the doors fit up against the door frames well.

3. Feeding several boilers through a main, branching with full size tees at each boiler, or even with a branch pipe a size smaller than the main, presents some interesting features, and the reasons for certain actions are not always apparent.

Of course, where there is a difference of several pounds in the pressure of the boilers, as for instance where boilers in same battery are used for different purposes at different pressures, all fed from the same source, there is a reason for a difference in water level.

Where the boilers are working together and are at the same pressure, as far as one can see, a slight difference that is not apparent to the gage, will sometimes influence the water level. The friction of an additional elbow or valve, or the looseness of a valve disc on the stem, so as to move with the flow of the water and partially retard the flow, will cause a disturbance in the water level.

Water in pipes has a tendency to shoot past the side opening of a tee and go on to the elbow at the end of the main, and if there be 3 outlets, the last one will get the most, the middle one (a tee) will get the least, and the first one (a tee also) will be second, assuming, however, that all the outlets are the same size and construction and the resisting pressure the same as near as can be seen.

4. We take it that your boiler is 40 ft. below the traps and that you carry 15 lb. pressure. If you carry boiler pressure on the system, also, the boilers being below the system, the condensate will return by gravity. If, however, the boilers are above the traps, or system, a double system of traps will perhaps be best. The advertising pages of Practical Engineer present reliable traps for every conceivable condition of service, and the manufacturers will gladly advise what trap to use upon receipt of the operating conditions.

5. As there are so many types and designs of pumps in addition to innumerable sizes, no definite answer can be given to the first part of this question. Speaking first, of the smaller pumps, such as are used as boiler feeders in the average plant, the simplex, or single cylinder pumps, usually have a lost motion device on the valve stem outside of the steam chest whereby the travel of the piston can be regulated so as to give maximum stroke without striking the heads.

This rule is not universal, however. Some simplex pumps have no outside connection between the piston and the valve. In the smaller sizes of duplex pumps, the corresponding device is located inside the steam chest, so that it is not possible to effect any changes without removing the chest cover. On sizes of about 8 in. stroke or a little larger, the lost motion device is on the link connecting the cross shafts to the valve stems, where adjustment can be made as required so as to obtain the maximum stroke without striking. Increasing the lost motion increases the stroke; decreasing it has the opposite effect.

On pumps of a larger size, say, about 12 in. stroke and above, in which class will be found fire pumps, and feed pumps for the larger plants, besides waterworks pumps, there are 2 ports leading from the steam chest to each end of each cylinder. The outside one is the steam port and the inside one the exhaust port.

Connecting these ports at any given end, is a cored passage in which is located a regulating valve so that the passage can be opened or closed at will. When the pump is running slow, this passage is opened more or less so that when the piston approaches the end of the stroke and covers up the exhaust port, part of the imprisoned steam in the cylinder is permitted to pass through the steam port to the regulating, or cushion valve, and thence into the exhaust port. In this manner, by adjusting these valves, opening to give less compression, and vice versa, the maximum stroke at any reasonable speed can be secured without striking the head.

6. There are any number of conditions, or combinations of them, that will cause pounding in an engine, and space will not permit more than briefly to mention a few of them. As a general thing, pounding in an engine is caused by too much lost motion in some bearing, pin, or connection and it remains for the engineer to examine carefully the conditions and adjust accordingly. Engines are freaky sometimes, running cool as long as permitted to make a little noise and move around some; but as soon as restrained a little, they cause trouble. All bearings and pins, if not adjusted frequently, have a tendency to "wear flat," as it is called, or to be more exact, out of round. Should this occur, care must be exercised in adjusting; for, if the adjusting be done diametrically with the worn part of the pin or bearing, as soon as the full part comes around, the box will generally be found too snug and will heat. It not infrequently happens that, although all bearings and pins are in perfect condition, pounding will be apparent. In a case of this kind, it will generally be found that the fault is in the valve setting. Unless one is acquainted with the operating conditions, he ought to apply the indicator before doing any keying up. If an engine has sheet or cast-iron guards over the crank or eccentrics, it frequently happens that these guards act as a receiver and give the impression that the pound is there, when as a matter of fact, it will more often than not be found in some distant place.

7. If the lights fluctuate, you will find that the voltmeter shows a change in voltage above and below normal. This is caused by the racing of the engine, the primary cause of which is in the governor or in the connections between it and the valve gear.

Dirt will work into the joints of a governor and cause friction, so that any sudden changes in load will not be promptly met by the engine. If grease be used on pins and bearings of a governor, it is liable to cause excessive friction by gumming, in time, unless it be an excellent grade of grease or else looked after frequently.

Shaft governors with roller bearings sometimes race after a few years' service, if allowed to gum up and wear the rollers. As a temporary means of stopping the racing until you can look into the matter carefully, gradually close the throttle until the engine shows steady, and then slowly open it again.

If a circuit breaker goes out so as to relieve the engine of considerable of the load, the efforts of the governor to assume the position of early cutoff will "over travel" and generally some part will bump up against a shoulder on a pin or spindle or against a little gum, in which case the governor will stick there till the speed is reduced below normal when the reverse takes place.

Lost motion caused by wear or lack of adjustment will affect the regulation of an engine of any type, more or less, as the governing device must move through too great a range in order to get control of the valve gear for a reverse movement.

G. H. Wallace.

Boiler Questions

SUPPOSE THE steam gage suddenly got out of order during a watch; what would I do?

2. In testing a boiler, how would you know the thickness of the plates and the defective ones?

J. S. F.

A. As the safety valve would preclude an overload on the boiler, and as you are accustomed to the speed of your engine working under a regular load, you would continue to run. In the meantime, remove and replace the steam gage, and have the defective one repaired.

2. Under a hammer test, while inside you can measure the thickness of the plates at the edges; the defective ones are found by sight and sound. The corroded spots and surfaces can be drilled out, thickness measured, tubes and flues sounded. Scale and its effects, and plates or heads thinned by external corrosion can be determined by sight and sound from the outside.

D. O. SCOTT.

Trouble With Air Compressor

I AM having trouble with a belt-driven Ingersoll-Rand air compressor. I removed the cooling pipes from the sub-base and found the small pipes almost solid with scale, which I renewed with an entire set of small pipes, reseated the discharge valves in both cylinders, removed both pistons and put inlet piston valves in good condition. After I put all parts of compressor together again, with every stroke of the piston in the high pressure side, water will be forced through the stuffing boxes and the intake pipe. Also, a large quantity of water is taken into the receiving tank in a day, and the cooling water as it leaves the compressor seems to shoot out in spurts as if air leaked into the water. What would cause this and how would you remedy it? P. D. M.

A. When troubles occur and inquiry is made as to the cause and the remedy, the inquirer should take all pains to give as full particulars as possible, as to dimensions and conditions of operation. In the case of an air compressor, it would be proper to give the cylinder dimensions, speed and delivery pressure; and in the case before us, the pressure of the circulating water becomes an important detail, which we can only guess at.

The compressor seems to have had a general overhauling and, as appears, a trouble has developed which did not exist before. We may dismiss at once any consideration of the condition of the inlet or discharge valves or of the pistons of the compressor, as they could not have had anything to do with it.

The case is peculiar in some respects, but evidently the real cause is a leak or leaks in the water pipes of the intercooler. The cooling water is circulated inside the pipes and the air pressure is outside them, and there is no pressure required for the water except the little that may be necessary to maintain the proper circulation of the water. The normal air pressure in the intercooler might be 20 to 25 lb. gage, which would be determined by the relative capacities of the 2 air cylinders, and would not be affected by the air delivery pressure. The air pressure in the intercooler might vary as much as 5 lb. at each cycle of the compressor, and it would seem that, assuming the leak to exist, the water pressure was so nearly that of the air in the intercooler, that at some point of the cycle some of the water would be discharged into the air and carried along to the high-pressure cylinder, while at another point of the cycle, the air pressure would be in excess and air would be forced into the water. If the water pressure were reduced to, say, 5 lb., no water would escape into the air when the compressor was running, but more air would be discharged into the water. This, of course, would not be a cure of the trouble, and it would entail some reduction of the normal compressed air delivery, if nothing else.

The only remedy is to stop the leak in the water pipes. The head to which the water pipes are all connected could be taken out and if water pressure was applied to the whole thing, the leak would be revealed, and it should be a simple job to cure it. After putting in a new set of pipes, they should have been tested by pressure in any case before they were put into the machine.

Water should not carry dirt in suspension and it should not carry lime and salts in solution; but, unfortunately, it does both, and the pipes should be regularly and thoroughly cleaned. As the best compressors are now designed, it is not difficult to get the pipes out.

Rheostat for A. C. Motor

WILL YOU explain why we cannot use a rheostat on an a.c. motor to start and control the speed, same as we do with d.c. motor? W. A. P.

A. You do not state in your question to what type of a.c. motor you have reference. An induction motor can have a rheostat in series with its stator windings and so obtain speed regulation; or, if it be a wound rotor induction motor, we may introduce resistances into the rotor circuits to produce speed variations. So that in these cases rheostats can be used, practically the same as for d.c. motors. A rheostat in the armature circuit is an inefficient method of speed control, however, as the total line voltage is at all times applied to motor and resistance terminals. The drop in the rheostat is a total loss and represents an actual wattage lost of I^2R, where I is the current and R the resistance.

In view of this inefficiency, transformers or compensators are used with a.c. motors, being so arranged that a range of voltage may be obtained by using different taps.

A synchronous motor, on the other hand, can not have its speed controlled by a rheostat, either in the rotor or stator circuits. It is true that a resistance could be used for limiting the starting current; but after the machine had come to speed and synchronism, the effect of this resistance on the speed would be absolutely nil. At the present stage of electrical science, we can not say why this is true, any more than we can say what electricity is; but the following explanation will show how a synchronous motor operates, and how resistance in the various circuits affects it.

A synchronous motor consists, generally speaking, of a stationary armature and a revolving field, the latter being separately excited precisely as an alternator has its fields excited.

In a polyphase armature or stator, the succession of (+), (—), and (0) values of current is such that every point in the iron becomes successively 0, +, 0, —, 0, +, etc. With reference to any one stator pole, it goes through the same cycle of magnetic events as when the field rotates past it; namely, first, say, a positive pole, then an air space, then a negative pole, etc. Bearing in mind that this cycle of magnetic events is produced by the currents in the stator (and would be produced equally well if the rotor were entirely removed) it is not difficult to see that the point which we can call the center of any north pole occupies successively different positions in the stator. In other words, a polyphase stator has set up in it by the currents passed through it, a revolving field, in which the poles are as clearly defined and rotate just as much as do the poles of the rotor of the motor when running; that is, in the rotor, the iron itself moves, while in the stator, the flux only moves, sliding along through the iron precisely like a set of "spirit poles." Every time the alternating current changes from + to —, this "spirit" pole moves one pole span as determined by the coils in the stator windings, so that we have in reality a "spirit" field in the stator, rotating synchronously with the driving generator. If the supply voltage is 60-cycle, the "spirit" field will revolve at a 60-cycle speed; if it has 4 poles, it will revolve 1800 r.p.m.; if 8-pole, 900 r.p.m., and so on. The speed of rotation of this "spirit" field is independent of the voltage impressed across stator terminals, as one alternation means a shift of one pole span, whether the voltage be 100 or 100,000.

We are justified in thinking of the revolving stator field as if there were the proper number of poles of constant polarity and the iron structure itself revolved.

If we now consider the effect of this revolving stator field upon the rotor, it will readily be seen that a north pole of the stator will tend to hold in juxtaposition with it a south rotor pole and vice versa,—remembering that "unlikes attract." Or, the rotor will rotate exactly as fast as the stator field rotates; a given north pole will follow a corresponding south pole continuously around the circle. If variations of voltage across stator terminals, as previously explained, do not in any way affect the speed of stator field, it is equally apparent that such variations will not affect the speed of rotation of the rotor. Similarly, it is apparent that the variations of rotor field strength will not affect speed, as the stator field speed is fixed, and the rotor poles follow the stator poles. If the stator voltage falls so low that there is not enough flux produced to exert sufficient force on the rotor field poles to keep them "following," the machine is said to "drop out of step," and the motor stops. If the field is greatly reduced in the rotor the motor does not necessarily stop, as there will be enough attraction between the unexcited iron and the stator poles to keep rotor moving. The nature of this attraction need not be explained here.

Thus we see that in a synchronous motor it is a case of a "whole loaf or none." Either the motor runs at synchronous speed or it stops. There is no slowing down, due either to field or stator voltage variations.

V. E. JOHNSON.

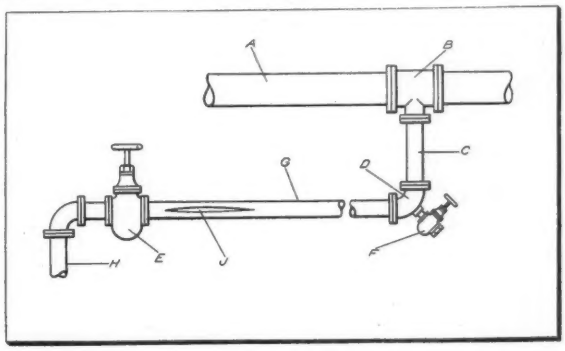
Unexplained Accident

I ENCLOSE a sketch showing a section of steam piping 10 in. in diameter. The tee marked b is at least 100 ft. from the boiler, and I believe runs around in a loop and connects to the boiler again, so as to feed both ways; b reduces to 5 in. and drops 18 in. to d, in which is a valve, f, while a horizontal pipe, g, runs to a gate valve, e, a distance of about 16 ft. on centers; pipe h leaves valve e, drops about 14 ft. and connects to an engine properly dripped and trapped.

The engine was shut down a week for repairs, during which time valve e was closed, allowing pipe g, ell d, and horizontal pipe c, to fill with water.

When repairs were completed, a man of ordinary knowledge of such matters went up on a ladder to open valve e; he had opened it but slightly when the pipe tore open, as indicated by j, and his head being in line with the center of rupture j, the explosive contents killed him.

The steam pressure was 180 to 190 lb. to the square inch, and the pipe and fittings from b to the engine were supposed to be standard weight, while in fact, the pipe was 1/32 below the standard thickness.



RUPTURED PIPE LINE

The accident occurred about 3 yr. ago, and at the time discussion arose among some prominent engineers in this locality as to the cause thereof. One side said that standard weight pipe was safe for 180 lb. steam pressure, and the general and common practice for all the large power plants was to use standard weight pipes and fittings; also, it was claimed the man should have opened valve f in order to draw the water off; the other side said that it was common practice to use extra heavy pipe and fittings for 180 lb. pressure and that a pipe should have been run from valve f to trap, which would have prevented water accumulating. Again in answer to the trap question, one engineer said it would be a crime to use or depend on a trap in such a case, while at the same time it was learned that they had 90 traps in use in the plant at the time of the accident.

What is the common practice, to use heavy or standard weight pipe and fittings for 180 to 190 lb. steam pressure per square inch? Would extra heavy pipe be apt to prevent such an accident? What was the approximate cause of the pipe opening up under the above condition? Should or should not the trap be used to prevent the water accumulation? Should the man have opened the valve f and drained off the water or not?

E. M.

PRACTICAL ENGINEER

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Continuous Tests

The value of a complete record of power plant performance has been proved in every plant where such a record has been kept. In many plants records have shown conditions which previously were not known to exist. The management has often been disappointed when the records show that the results of every operation do not come nearly up to the results obtained by the testing engineer when the acceptance test was made and wants to know why his apparatus in daily operation is so far below test results.

Invariably he is told that test conditions are always made favorable to the apparatus being tested, sacrificing the performance of all other apparatus in the plant so that higher results than obtainable under operating conditions are secured which make a good showing to the owner.

This discrepancy between test and operating results has led, in some plants, to what might be called continuous tests. Until recently such operation would have proved expensive and no economy would have resulted owing to the observers necessary to carry on these tests. Today, however, recording and integrating instruments are available for measuring nearly every variable quantity or condition about the power plant which has to do with performance; these require but little attention once a day and leave the operators free from bookkeeping to look after operating conditions.

The question arises, "How far should these tests be carried?" This can be answered only for individual plants, for much depends upon the size and services rendered. In one plant serving a small factory there are 2 boilers, equipped with underfeed stokers, furnishing steam to one generating unit. Most excellent results in economy have been secured here, with one man operating the plant 12 hr. a day. He is aided in his work by the common indicating instruments, but keeps no records. A stroke counter is attached to the plungers of the stokers and these have been roughly calibrated; water used in the plant is measured by a water meter in the city supply line; a V-notch meter records the feed water and an integrating wattmeter tells the output of the generator. The recording instruments are looked after by an office clerk.

These instruments give the manager all he cares to know—cost per kilowatt hour of his current. So long as this cost, including interest, etc., is below what the central station would charge him, he considers his investment profitable.

In a central station, where the chief engineer is the man who "wants to know," the following instruments are installed and the records kept by an office clerk: automatic coal scales to each boiler, ash scales, recording feed water meter, recording steam flow meter on each boiler, recording CO_2 meter, recording steam and vacuum gages, recording thermometers on feed water heater, feed water from economizer, flue gas to and from economizers, inlet and outlet condenser water, recording and integrating wattmeters; in fact, no variable which has any significance to the engineer is without an automatic record.

Whereas, during acceptance tests usually made upon individual machines or units, conditions are maintained

best for that machine, during the continuous test an overall result is desired, taking conditions as they may be thrust upon the plant, varying the operating conditions of the different apparatus under the control of the engineer in such a way as to give highest results. During such a test, which, in fact, should never cease, the analysis of results and conditions should be so complete and the instructions to operators so definite that any variation of conditions outside the control of the plant will be met with an exact change within the plant to keep the efficiency at the top notch. In many cases it is necessary to sacrifice the efficiency of one unit in order to gain a greater economy in another; it's the work of the engineer to solve this problem for his own plant and the continuous test is the greatest aid.

Correction Notice

In the article on "Flywheel Weights for Internal Combustion Engines" in Aug. 1 issue, will be found on page 788, the formula $W = 3600\ gE \div 4\ pi2\ R\ 2\ N\ 2\ K$, which should read, $W = 3600\ gE \div 4\ pi^2\ R^2\ N^2\ K$.

News Notes

For serving customers in the vicinity of Boston, the Bristol Co. has established a district branch office at Boston, with F. H. Emerson as Boston district manager and headquarters in the Old South Building, where telephone messages can be left for him. This year is the twenty-fifth anniversary of the founding of The Bristol Co., and its plant has grown at the rate of doubling the floor space once every 5 yr. during the last 20 yr.

Joseph T. Ryerson & Son announce the establishment of warehouses in St. Louis for immediate service in their lines of finished steel to customers in the territory tributary to St. Louis, taking over the plant, merchandise, equipment and good will of the W. G. Hagar Iron Co., and supplementing this plant with complete modern warehouses and equipment for the handling and cutting of shapes, plates, reinforcing bars and similar heavy material.

The Public Service Electric Co. has made known its intention of rushing the work on its new power station at Point-no-Point, which is ultimately to assume gigantic size and cost a matter of $10,000,000, by awarding the contract for foundation construction. The plant is to be erected on the banks of the Passaic River, north of Lincoln highway, and will be the largest of its kind in the world when completed.

Linde & Griffith of Newark, N. J., got the contract at their bid of approximately $160,000. The firm had previously been awarded a $100,000 contract for dredging and dock work at the plant. The company announces that work will be started immediately.

There will be built 2 concrete foundations for a turbine-room, boiler-house, outside coal bunker and detached switch house. The maximum size of the main building will be 160 by 264 ft. It will be constructed on piles, so as to bring the floor level 6 ft. above the surface of the meadows. About 8,000 piles, ranging in length from 35 to 55 ft., will be driven, and there will be approximately 14,000 cu. yd. of concrete and about 20,000 cu. yd. of excavating, besides considerable coffer dam work. The job is to be finished next March. In the preparation of the plans, General Manager Dudley Farrand and Chief Engineer N. A. Carle visited a number of the leading power plants in the country, and the new station will embody what they believe to be the best features of plant construction in use anywhere. One of the new ideas will be a detached switch house, which will be 70 by 105 ft. in dimensions, and will be the first of its kind in the East. Another new feature, not to be found in the metropolitan district, will be an outside coal bunker to feed the boiler-room. The turbine room adjoining the boiler-house will be 95 by 150 ft. in size, and will accommodate 3 turbo-generators of 25,000 kw. capacity each.

Graphite Lubricating Co., Bound Brook, N. J., announces the death, on July 20, of its president, Charles H. Libbey.

The $100,000 Electric light and pumping station, Grafton, W. Va., was placed in operation recently, after having been in process of construction for more than a year. The plant is one of the largest and most modern in the State. The new pump has a capacity of 4,000,000 gal. in 24 hr.

Plans are under way for a projected water works, sewage and electric light system, to be installed in Ceiba, Honduras, at an estimated cost of $500,000. The water system will be by gravity from the mountains, and the fall used to generate power for electric lights for the city. The matter is at present in the hands of the city officials. Further information can be obtained from Consul Walter F. Boyle, of Ceiba.

The Penn Central Light and Power Co., which supplies current to many communities and mining operations near Johnstown, Pa., is preparing to place in operation its new million dollar plant at Williamsburg, Blair County. The Penn company's field of operation extends from Vintondale to Lewistown, and one of the dynamos alone will furnish enough current to supply the entire city of Altoona, including the Pennsylvania shops. The 2 plants at Altoona will not be used after the new one gets into working order, although one of them will be held in reserve for use in case of accident.

Carl Kauhl, of Mexia, Tex., has been awarded the contract to build for the Mexia Water, Light and Power Co., a modern brick power house. Work on this building will begin as soon as the brick can be burned by the Mexia Pressed Brick Co. O. H. Brannon, general manager, says that his company, recently organized and chartered for $145,000, will spend $25,000 in betterments and extensions in the near future. Contracts have been given for additional machinery. The essential parts of the machinery in this plant will be in duplicate, with all parts interchangeable, affording continuous service. When finished, no plant in the State will be more complete. The supply of water for domestic use is pumped by electric power from a spring with a capacity of 1,500,000 gal. daily. For industrial plants, the company has surface supply of 50,000,000 gal. This company owns and operates the sewerage system of the city. Engines of 300 hp. pull the machinery of this plant and its boilers consume 6,000,000 cu. ft. of natural gas each month.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Brass Ball Disc Valves

REGRINDING of valve seats and renewing of valve discs are done away with, it is claimed, by the use of a brass ball disc. This type of valve has been developed by the Farrell Valve Specialty Co., which has recently sold manufacturing rights to the Pratt & Cady Co., of Hartford, Conn. In appearance, this valve is no different from the standard P. & C. valve; in fact, the standard valve has been used except that, instead of the renewable asbestos disc which has been used heretofore, a cage holding a ball of hard rolled brass or nickel steel has been substituted.

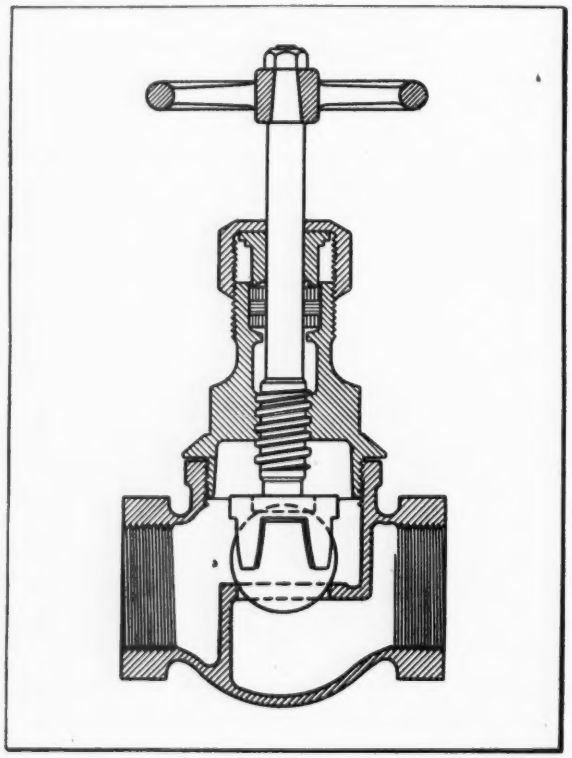


FIG. 1. SECTIONAL VIEW OF VALVE

The ball is held rather loosely by the claw, fitting a concave recess in the end of the valve stem, which holds the ball rigidly to the seat when closed; each time the valve is opened this construction allows the ball to turn more or less so that when closed, it finds a new seat, and there is no tendency to wear the disc.

The valve seat is made to give line contact with the ball; but, as it is used, the ball gradually forms its own seat, which it maintains by means of the rotating feature. Should the ball become scored from any cause, it is easily replaced by slipping it out of its cage and pushing in a new one.

Other features of the valve are that it has a rising stem, with collar at the top of threads, which comes in contact with the bonnet when in its upper position, making a steam tight joint. This allows the valve to be packed in either the open or closed position. The stuffing box is provided with a heavy gland, which forces the packing firmly into position.

FIG. 2. PARTS OF THE PRATT & CADY BALL DISC VALVE

It is claimed these valves can be used in any steam, water, air or gas line, against high or low pressure. They serve well as boiler blowoffs, also in pulp mills and laundries where considerable foreign matter passes. As throttle valves, wire drawing does not cause a scored disc as the ball rotates with the least friction in any direction and the seat is reground each time it is closed.

The illustrations show the parts of the valve, which is made in all sizes up to 2 in., also a section of the assembled valve.

The Fulton Diesel Oil Engine

AMERICAN MANUFACTURED DIESEL TYPE OIL ENGINES IN SMALL SIZES

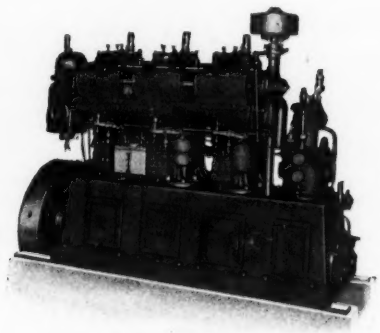
THE Fulton Manufacturing Co., of Erie, Pa., has placed upon the market what is claimed to be the smallest Diesel type oil engine built on the American Continent.

As shown in the accompanying figure, this engine is of the vertical, single-acting, 4-cycle, high-speed, heavy-duty type with fully enclosed crank case, which is bolted to the engine bed on the center line of the crank shaft. Large hand-hole covers give easy access to the inside of the case for repairs or adjustments, while large end plates facilitate the removal of the crank shaft without raising the engine or separating the case from the bed.

All parts of the Fulton engine are made of high grade materials and of ample proportions, insuring rigidity and long life of all wearing parts.

A plunger pump delivers the fuel to the injector and atomizer, located in the center of the cylinder head, where it is mixed with high pressure air and forced into the cylinder at the proper time. The fuel system may be charged, when necessary, with the same pump by hand without disconnecting the power drive. High pressure air for fuel injection and starting is supplied by a 2-stage air compressor having superimposed pistons and driven directly from the main crank shaft.

Free air is drawn into the larger of the compressor cylinders and compressed to approximately 120 lb. pressure, after which it is drawn into an inner cooler and then into the high-pressure cylinder to be compressed to from 825 to 975 lb. per sq. in. The air then passes through a second cooler, after which it is stored in the small air receiver for fuel injection. The surplus air compressed for fuel injection is stored in 2 large tanks to be employed for starting purposes, and maintained at any pressure from 700 to 1000 lb. per sq. in.; while the pressure of the injection air should vary with the load, 800 lb. being recommended at ½ load, 975 lb. for full load, and approximately 1000 lb. at 10 per cent overload.



THE FULTON DIESEL OIL ENGINE

A separate pump on each cylinder is provided for the injection of the fuel and so arranged that any or all may instantly be cut in or out at the will of the operator.

The body of the fuel injector is made of bronze in 2 parts and can readily be removed for inspection, cleaning or repairing. The needle valve is of nickel steel, ground to size and seated in the lower half of the valve body. This valve is closed by a heavy compression spring and opened by a lever actuated by a cam mounted on the cam shaft.

A system of 4 pumps for cooling water, fuel supply, lubrication and bilge is located on the front of the crank case, arranged so that they are interchangeable and in case of emergency one can be substituted for the other; that is, the bilge pump can be attached to the cooling system, or the fuel supply pump to the lubricating system.

A centrifugal type of governor, with exposed adjustment, mounted on a vertical shaft and supplied with a hand control to increase or decrease the engine speed at the will of the operator by regulating the amount of oil delivered by the fuel pumps, is employed on this engine. This hand mechanism consisting of a handle and wheel supplemented by interlocking push buttons, provides the operator with every necessary means for safe and easy control. The handle has the 3 positions of "barring," "air start" and "running." The push buttons serve to connect or bypass the fuel for any cylinder when the handle is in position for "running"; these buttons are so interlocked with the handle that starting air and fuel cannot be supplied to a given cylinder at the same time.

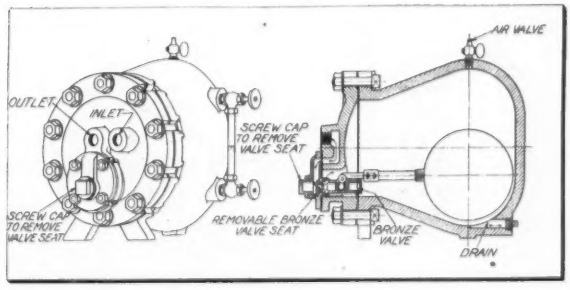
The cylinders on which the air start is provided, must be bypassed before the handle can be placed in "air start" position. With handle in barring position, all fuel is bypassed so that, should the engine be turned over several times, the cylinders cannot become flooded with fuel oil.

It is claimed by the manufacturers that these engines have a thermal efficiency of 32 to 35 per cent, which is comparatively high for an internal combustion engine.

New Golden-Anderson Steam Trap

IN the accompanying illustration are shown views of the new Golden-Anderson high or low pressure steam trap, recently developed by the Golden-Anderson Valve Specialty Co., of Pittsburgh. The distinctive features of this trap are its simplicity of construction and operation and the ease with which the working parts can be removed for inspection and repair.

The trap is of the float type with the head bolted to a flange on the body, but instead of holes, slots are used for the bolts which makes removal of the head easy and rapid. The same method is used for fastening the valve mechanism to the head of the trap.



EXTERIOR AND CROSS SECTION OF GOLDEN-ANDERSON STEAM TRAP

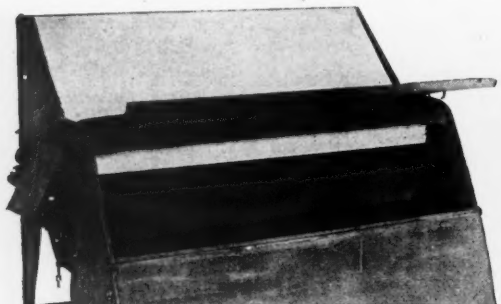
The inlet and outlet connections are both to the head of the trap, but these need never be broken unless it is found necessary to remove the float for all the valve mechanism is attached to a separate cap. The valve seat is of bronze and may be inspected or removed by taking out the screw cap. The valve also is of bronze and of the plunger type, operated positively by the float.

A water column, an air valve and a drain are provided to aid the operator in caring for the trap.

Compact and Efficient Blueprinting Machine

WICKES Bros., Saginaw, Mich., have just placed on the market a blueprinting machine which makes prints of from 2 to 48 in. in width and of any length, and occupies a floor space of but 2½ by 5 ft.

Interesting and convenient features of this machine are that either separate or continuous prints may readily be made, that the work can be carried on in a lighted room, that the operator performs all operations from the front of the machine and the tracings, when printed, can be delivered either to him or in the compartment in the rear.



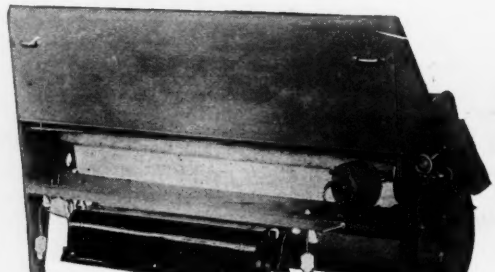


FIG. 1. FRONT VIEW OF WICKES BLUEPRINTING MACHINE
FIG. 2. REAR VIEW OF WICKES BLUEPRINTING MACHINE

Tracings and paper are fed into the machine on an endless, automatically tightened belt operated by a small electric motor, and then passed around the printing cylinder, which consists of spirally disposed bronze wires, so arranged that the paper and tracings are kept perfectly smooth while passing around. The manufacturers claim that this wire offers less obstruction to light than a cylinder of glass, produces prints of a uniform tone, and is self-cleaning and practically indestructible.

Due to its richness in chemical rays with actinic powers, a Cooper-Hewitt mercury vapor lamp is employed, which, together with the small driving motor, takes a current of only 5 amp. at 110 volts, and it is estimated that the cost of printing does not exceed ¼ cent per square foot of paper.

Combined Barometer and Vacuum Recorder

ONE of the most important factors in the economy of steam consumption for power purposes is the absolute back pressure. To reduce this back pressure to a minimum is the office of the condenser; it is, therefore, most desirable if not absolutely necessary to keep close tab on the condenser. For this purpose, vacuum gages and recorders are installed.

Ordinary vacuum gages and recorders, however, do not indicate or record the back pressure directly nor correctly. The vacuum as recorded varies with the barometer at the same time and place, whereas, the absolute back pressure in the condenser is independent of the barometric pressure, but is always equal to the difference between the two. The nearer the vacuum approaches the barometer, the lower the back pressure, and vice versa.

The Uehling combined barometer and vacuum recorder puts these 2 records in juxtaposition on the same chart. Using the barometer record as the base line, the absolute back pressure can be correctly read off directly from the chart.

BAROMETER AND VACUUM RECORDER

It consists of 2 float chambers, one connected with a barometric mercury column, the other with a mercury column in communication with the condenser, these columns and double float chambers being secured to the case of the recorder. The pens are actuated by the floats and move in correct harmony with the barometric pressure and the vacuum. The instrument is made by the Uehling Instrument Co., Passaic, N. J.

N. A. S. E. Convention

FROM Sept. 7 to 11, the sessions of the 32nd Annual Convention, N. A. S. E., will be held in Milwaukee, Wis., the meetings being in the Auditorium, and the hotel headquarters at the Wisconsin.

Monday, the 7th, will be devoted to reception of delegates and visitors, with the official opening of the mechanical exposition at 8 p.m. Addresses will be given by chairman of the local convention committee, J. A. Wickert, by Homer Whelpley, president of the N. E. A., and by F. L. Ray, vice-president of the N. A. S. E. The official opening will be made by J. R. Coe, president N. A. S. E.

Tuesday morning will be devoted to the opening exercises, with speeches of welcome and responses, and the appointment of committees. In the afternoon there will be a business meeting to receive reports of committees, also a meeting of the Life and Accident Department, and of the Ladies Auxiliary. At 3:30 Tuesday afternoon there will be a trip to the plant of the Rich-

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

LOSS OF HEAD IN FEET DUE TO FRICTION OF WATER IN 100 FT. OF SMOOTH, STRAIGHT, CAST-IRON PIPE

Gals. per Min.	1 inch		1¼ inches		1½ inches		2 inches		2½ inches		3 inches		4 inches		5 inches		6 inches		8 inches		10 inches		12 inches	
	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.
5	1.80	2.30																						
10	3.61	7.85	1.97	2.18																				
15	5.41	16.50	2.96	4.62	2.04	1.53																		
20	7.22	28.10	3.94	7.90	2.72	2.61	1.53	0.81																
25	9.02	42.50	4.93	11.90	3.40	3.95	1.91	1.23	1.53	0.49														
30	10.83	59.50	5.91	16.70	4.08	5.53	2.29	1.72	1.84	0.68	1.27	0.25												
35	12.63	79.00	6.90	22.20	4.76	7.35	2.67	2.29	2.14	0.91	1.48	0.33												
40	14.44	101.00	7.88	28.40	5.44	9.40	3.05	2.93	2.45	1.16	1.69	0.42												
45	16.24	126.00	8.87	35.20	6.12	11.70	3.44	3.64	2.75	1.44	1.91	0.52												
50	18.05	153.00	9.85	42.80	6.80	14.20	3.82	4.42	3.06	1.75	2.12	0.63												
60			11.82	60.00	8.16	19.90	4.58	6.20	3.67	2.45	2.55	0.88	1.43	0.22										
70			13.79	79.80	9.52	26.50	5.35	8.25	4.29	3.26	2.97	1.17	1.67	0.29										
80			15.76	102.00	10.88	33.90	6.11	10.50	4.90	4.16	3.40	1.49	1.91	0.37										
90			17.73	127.00	12.25	42.20	6.88	13.10	5.51	5.18	3.82	1.86	2.14	0.46										
100			19.70	154.00	13.60	51.30	7.64	15.90	6.12	6.29	4.25	2.25	2.39	0.56										
120					16.32	72.00	9.17	22.30	7.34	8.82	5.10	3.16	2.86	0.78	1.83	0.27								
140					19.04	95.80	10.70	29.70	8.57	11.70	5.95	4.20	3.34	1.04	2.14	0.36								
160					21.76	122.00	12.23	38.00	9.79	15.00	6.80	5.38	3.82	1.33	2.44	0.46								
180							13.75	47.30	11.02	18.60	7.65	6.68	4.30	1.65	2.75	0.57	1.91	0.19						
200							15.28	57.50	12.24	22.60	8.50	8.12	4.78	2.01	3.05	0.69	2.12	0.23						
225							17.19	70.00	13.77	27.50	9.56	9.88	5.38	2.45	3.44	0.84	2.39	0.28						
250							19.10	83.50	15.30	32.80	10.63	11.80	5.97	2.92	3.82	1.00	2.65	0.33						
275							21.01	98.00	16.83	38.50	11.69	13.80	6.57	3.42	4.20	1.17	2.92	0.39						
300							22.92	113.00	18.36	44.50	12.75	15.90	7.16	3.94	4.59	1.35	3.18	0.45						
350									21.42	59.00	14.88	21.10	8.36	5.24	5.35	1.80	3.72	0.60						
400									24.48	75.50	17.00	27.00	9.55	6.70	6.12	2.30	4.25	0.76						
450											19.13	33.60	10.75	8.34	6.89	2.86	4.78	0.95						
500											21.25	40.80	11.94	10.10	7.65	3.47	5.31	1.15						
550											23.38	48.80	13.14	12.10	8.42	4.15	5.84	1.38						
600													14.33	14.10	9.18	4.84	6.37	1.61						
650													15.52	16.20	9.95	5.56	6.90	1.85						
700													16.72	18.40	10.71	6.32	7.43	2.10						
750													17.91	20.80	11.48	7.14	7.96	2.37						
800													19.10	23.30	12.24	8.00	8.49	2.66						
850													20.29	26.00	13.00	8.92	9.02	2.96						
900													21.48	28.80	13.77	9.88	9.55	3.28						
950													22.67	31.80	14.53	10.90	10.08	3.62						
1000													23.86	34.90	15.30	11.96	10.61	3.97						
1100															16.83	14.50	11.67	4.82						
1200															18.36	17.20	12.73	5.72						
1300															19.89	20.10	13.79	6.70						
1400															21.42	23.30	14.85	7.75						
1500															22.95	26.70	15.91	8.88						
1750																	18.56	11.80						
2000																	21.21	15.10						
2250																	23.86	18.80						
2500																			1.90	0.19				
2750																			2.09	0.23				
3000																			2.28	0.27				
3250																			2.47	0.31				
3500																			2.66	0.36				
3750																			2.85	0.41				
4000																			3.04	0.46				
4500																			3.42	0.58				
5000																			3.80	0.71	1.40	0.09		
6000																					1.68	0.13		
7000																					1.96	0.17		
8000																					2.24	0.22		
9000																					2.52	0.28		
10000																					2.80	0.34		

When Pipe is Slightly Rough, Add 15%; When Very Rough, Add 30%

VEL.=Velocity in Feet per Second

FRIC.=Friction Head in Feet

CHART III—COMPARATIVE COST OF STANDARD PILLOW BLOCKS

A-BALL & SOCKET PILLOW BLOCK - ROLLER BEARING
B-B. & S. PILLOW BLOCK-RING OR CHAIN OILING BEARING
C-B. & S. PILLOW BLOCK-PLAIN BEARING
D-RIGID PILLOW BLOCK-ROLLER BEARING
E-RIGID P.B. - RING OR CHAIN OILING BEARING
F-RIGID P.B. - WICK OILING BEARING
G-RIGID P.B.-PLAIN BEARING
COMPARATIVE COST-BASE:-COST OF / "RIGID PILLOW BLOCK, PLAIN BEARING = /
DIAMETER OF SHAFT IN INCHES

CHART V—COMPARATIVE COST OF STANDARD DROP HANGERS OR FLOOR STANDS

Cost of 1-in. Hanger (8-in. drop) plain bearing = 1.

TABLE SHOWING LENGTH OF COPPER WIRE OR CABLE FOR A DROP OF ONE VOLT

Computed on Basis of Standard Annealed Copper at 16 C.=60 F.

B.&S. Gage	AMPERES																							
	2	5	10	12	17	24	35	46	54	68	76	90	107	127	150	179	210
	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.
14	201	81	40	34	28	20											
12	320	128	64	53	38	32											
10	509	204	102	85	60	48											
8	809	324	162	135	96	69	49										
6	1280	514	257	215	151	107	76	56									
5	1610	649	325	270	191	135	98	71	60								
4	2060	810	409	341	241	171	124	89	76	63							
3	2580	1030	516	430	304	215	156	112	95	79	68						
2	3250	1300	651	543	383	271	197	142	120	100	86	72					
1	4100	1640	821	684	483	342	249	176	152	126	108	91	77				
0	5170	2070	1030	862	608	431	313	225	196	159	136	116	97	81			
00	6530	2610	1300	1090	768	544	396	284	246	201	172	145	122	103	87		
000	8230	3290	1650	1370	968	686	498	358	309	253	216	183	154	130	110	93	
0000	10370	4150	2080	1730	1220	864	628	451	389	319	273	231	194	163	138	117	99

B.&S. C.M.	AMPERES																							
	10	50	100	127	150	177	210	300	270	350	390	460	500	550	600	650	700	750	800	850	900	950	1000	1100
800,000	1960	392	196	154	131	111	93	98																
500,000	2940	588	294	232	196	166	140	147	109															
400,000	3920	784	392	309	261	222	187	196	146	119														
300,000	4900	980	490	386	327	277	233	246	182	149	126													
600,000	5880	1180	588	463	392	332	280	294	218	178	151	121												
700,000	6860	1370	686	541	458	388	327	342	254	208	176	153	137											
800,000	7840	1570	784	618	523	445	375	389	290	238	201	174	157	143										
900,000	8820	1760	882	695	588	499	420	441	327	267	226	196	176	160	146									
1,000,000	9800	1960	980	772	654	554	467	490	363	297	251	218	196	179	163	151								

LOSS OF HEAD IN FEET DUE TO FRICTION OF WATER IN SMOOTH 90 DEG. ELBOWS

Gals. per Min.	1 inch		1¼ inches		1½ inches		2 inches		2½ inches		3 inches		4 inches		5 inches		6 inches		8 inches		10 inches		12 inches	
	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.
5	2.04	0.06	1.30	0.14																				
10	4.08	0.22	2.60	0.51																				
15	6.12	0.47	3.90	1.07	2.73	0.21																		
20	8.16	0.80	5.20	1.82	3.64	0.36	2.60	0.09																
25	10.20	1.35	6.50	2.75	4.55	0.54	3.25	0.13																
30	12.24	1.93	7.80	3.86	5.46	0.77	3.90	0.18	2.89	0.09														
35	14.28	2.57	9.10	5.13	6.37	1.03	4.55	0.24	3.37	0.11														
40	16.32	3.40	10.40	6.57	7.28	1.32	5.20	0.30	3.85	0.14	2.60	0.06												
45			11.70	8.19	8.19	1.64	5.85	0.38	4.33	0.18	2.93	0.08												
50					9.10	1.99	6.50	0.46	4.81	0.22	3.25	0.10	1.79	0.05										
100					12.74	3.90	9.10	1.65	6.73	0.77	4.55	0.34	2.50	0.17										
150							11.70	3.50	8.65	1.64	5.85	0.72	3.58	0.35	2.30	0.10								
200									10.57	2.80	7.80	1.23	4.78	0.61	3.07	0.18								
250									13.21	4.23	9.75	1.85	5.97	0.92	3.84	0.27								
300											11.70	2.60	7.17	1.29	4.61	0.38								
350											13.65	3.46	8.36	1.72	5.38	0.51								
400													9.55	2.20	6.14	0.65								
450													10.75	2.74	6.91	0.81								
500													11.94	3.33	7.68	0.98								
750															11.52	2.08								
1000															15.36	3.54								
1250																								
1500																								
2000																								
2500																								
3000																								
3500																								
4000																								
4500																								
5000																								

Table Shows Loss for One Elbow, and is Based on Weisbach's Formula for Short Radius Bends

When Elbow is Slightly Rough, Add 15 %; When Very Rough, Add 30 %

VEL. = Velocity in Feet per Second FRIC. = Friction Head in Feet

CHART IV—COMPARATIVE COST OF STANDARD PILLOW BLOCKS

Base:—Cost of Plain Pillow Blocks Taken as 100 Per Cent

Proportional cost of Rigid Pillow Blocks:
- Curve B—Plain bearing (Base = 100 per cent).
- Curve a—Wick oiling bearing.
- Curve b—Ring or chain oiling bearing.
- Curve c—Roller bearing.

Proportional cost of Ball and Socket Pillow Blocks:
- Curve B—Plain bearing (Base = 100 per cent).
- Curve d—Ring or chain oiling bearing.
- Curve e—Roller bearing (Univ. Adj.).

CURRENT REQUIRED BY D.C. MOTORS

H. P.	Percent Efficiency	Watts	Volts 110	115	120	125	220	250	500	525	550
¾	65	860	7.82	7.48	7.17	6.88	3.91	3.44	1.72	1.64	1.56
1	65	1,148	10.4	9.98	9.57	9.18	5.22	4.59	2.30	2.19	2.09
2	65	2,295	20.8	20.0	19.1	18.4	10.4	9.18	4.59	4.37	4.17
2½	75	2,487	22.6	21.6	20.7	19.9	11.3	9.95	4.97	4.74	4.52
3½	75	3,480	31.6	30.3	29.0	27.8	15.8	13.9	6.96	6.63	6.33
5	80	4,662	42.4	40.5	38.8	37.3	21.2	18.6	9.32	8.88	8.48
7½	80	6,994	63.6	60.8	58.3	56.0	31.8	28.0	14.0	13.3	12.7
10	85	8,776	79.8	76.3	73.1	70.2	19.9	35.1	17.6	16.7	16.0
15	85	13,165	120.	114.	110.	105.	59.8	52.6	26.3	25.1	23.9
20	90	16,578	151.	144.	138.	133.	75.4	66.3	33.2	31.6	30.1
25	90	20,722	188.	180.	173.	166.	94.2	82.9	41.4	39.5	37.7
30	90	24,867	226.	216.	207.	199.	113.	99.4	49.7	47.4	45.2
40	90	33,155	301.	288.	276.	265.	151.	133.	66.3	63.2	60.3
50	90	41,444	377.	360.	345.	332.	188.	166.	82.9	79.0	75.4
75	90	61,022	555.	530.	508.	488.	277.	244.	122.	116.	111.
100	90	74,600	678.	649.	622.	597.	339.	298.	149.	142.	136.
100	93	80,215	729.	697.	668.	642.	365.	321.	160.	153.	146.
125	93	100,269	912.	872.	836.	802.	456.	401.	200.	191.	182.
150	93	120,323	1,094.	1,046.	1,003.	963.	547.	481.	241.	229.	219.

—Simplex Wire & Cable Co.

COMPARISON OF BELTING

A single leather belt (about 9-32nds-in. thickness) is equal to..... 4-ply balata
A light double leather belt is equal to..... 6-ply "
A heavy belt is equal to..... 8-ply "
Lighter belts are proportionately weaker.
According to the makers' lists:—

A 4-ply Gandy belt is equal to 3-ply balata
A 6-ply " " 5-ply "
A 8-ply " " 7-ply "
A 10-ply " " 9-ply "

A 3-ply belt is suitable for 3-in. diameter pulleys and under
A 4-ply " " 4-in and not less than 3 inches.
A 5-ply " " 12-in. " " 5 "
A 6-ply " " 16-in. " " 10 "
A 7-ply " " 18-in. " " 15 "
A 8-ply " " 24-in. " " 18 "
A 9-ply " " 36-in. " " 24 "

Belt speed = Pulley diam. in inches $\times$ r.p.m. $\times \frac{11}{42}$

Horsepower at 1000 ft. a minute belt speed for

Inches Width	3 Ply (Canvas and Balata). 4	4 —	5 6	6 —	7 8	8 —	9 10
	Ply (Gandy).						
		Single Leather		Light Double Leather		Heavy Double Leather	
2 ..	2.4	3.0	3.6	4.3	4.8	5.5	6.0
3 ..	3.6	4.5	5.4	6.4	7.2	8.25	9.0
4 ..	4.8	6.0	7.2	8.6	9.6	11.0	12.0
5 ..	6.0	7.5	9.0	10.8	12.0	13.75	15.0
6 ..	7.2	9.0	10.8	12.9	14.4	16.5	18.0
7 ..	8.4	10.5	12.6	15.0	16.8	19.25	21.0
8 ..	9.6	12.0	14.4	17.2	19.2	22.0	24.0
9 ..	10.8	13.5	16.2	19.4	21.5	24.75	27.0
10 ..	12.0	15.0	18.0	21.5	24.0	27.5	30.0

—Engineer in Charge.

ardson-Phenix Co., and at 8:30 in the evening a card party for ladies in the Auditorium, and at 10 p. m., a smoker for the men, under the auspices of the N. E. A.

Wednesday morning will be devoted to sessions of the convention and the Ladies Auxiliary, with a trip to the works of the Allis-Chalmers Co. at 11:30, where luncheon will be served. At 8 o'clock there will be a band concert in the Exposition Hall in the Auditorium.

Thursday morning will be devoted to business sessions and the afternoon to a field day, including athletic events, baseball game and other amusements. Thursday will be Ladies Day at the mechanical exposition, and souvenirs will be given on this day only. At 8:30 p.m. there will be a vaudeville performance in Plankinton Hall Auditorium, in charge of the N. E. A.

Friday morning and afternoon will be given up to business sessions. At 8:30 p.m. there will be the installation of officers, presentations of gifts of remembrance to the retiring officers, and the closing ball in Engelman's Hall in the Auditorium. Saturday will be available for visits to places of interest about the city.

During this same period, the Wisconsin State Association will hold its annual convention, the opening exercises being at 2 p.m. Sunday, Sept. 6, at the Republican House, and the final session on Monday morning.

Books and Catalogs

STATISTICAL ABSTRACT OF THE UNITED STATES, 1913, compiled by the Bureau of Foreign and Domestic Commerce, gives tables comparing the area, commerce, and other economic factors of the United States with those of other leading countries. Other comparative tables further emphasize its commercial power and its strong international position as indicated, for example, by comparative railway and telegraph mileage and public debt.

Historical tables show that the general tendency of the course of American commerce is ever higher, the foundations of its growth being laid deep in the soil and natural resources of the country and in the character of the people. Data relating to education, labor, finance, prices and other facts affecting the economic life of the people are also contained in the abstract, which may be procured from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 50 cents a copy.

WESTINGHOUSE Wicker Type Electric Linotype Pots is the title of an elaborate publication (No. 1531) just issued by the Westinghouse Electric & Mfg. Co. The linotype pot is thoroughly described and illustrated and its advantages are explained in detail.

FROM GREENE, TWEED & CO., 109 Duane St., New York, we have just received a copy of the latest catalog illustrating and listing the company's Rochester automatic lubricators.

THE TWIN STRAINER as an accessory to the Central Station is discussed in Bulletin No. 85 lately issued by the Elliott Co., 6910 Susquehanna St., Pittsburgh, Pa.

CENTRAL STATION TRANSFORMERS are described and illustrated in Bulletin 105 from Wagner Electric Mfg. Co., St. Louis, Mo.

NEW FOLDERS, one of which is an insert for Ohio Valve Catalog No. 50, have been received from The Ohio Brass Co., Mansfield, Ohio.

A. D. GRANGER CO., 90 West St., New York, has issued Bulletin No. 2, relating to "Oswego" internally fired water-tube boilers.

INTERNALLY FIRED Scotch marine boilers with water backs, built by Murray Iron Works Co., Burlington, Ia., are described and illustrated in a catalog recently received.

FROM STONE COLD to Full Power in 10 Seconds is the title of Bulletin A M, describing the Harris valveless engine (Diesel principle) and issued by The Harris Patents Co., 200 Fifth Ave., New York.

THERMOGRAPHIC RECORDS of the temperature obtained for one week in a residence having a hot water heater, with and without the "Minneapolis" heat regulator, are shown in the circular of Nason Mfg. Co., 71 Fulton St., New York.

GENERAL ELECTRIC CO.'S Bulletin No. 46,201 describes and illustrates a new type of watthour meter operating on the induction principle, a result of study and experiment to produce a watthour meter of high initial and sustained accuracy, of pleasing appearance and simple construction. The bulletin explains the advantages of the new construction, in which the base or central iron casting supports the complete motor element, damping magnets, bearings and registering mechanism; the electrical element is mounted on the inside and the damping and moving element on the outer or front side, while an extension at the bottom forms the terminal chamber.

BALDWIN-WESTINGHOUSE electric industrial locomotives, for use in industrial plants, on plantations and for similar service, are the subject of a recent Westinghouse Electric & Mfg. Co. circular.

Trade Notes

THE SKINNER ENGINE CO. of Erie, Pa., have discontinued their former selling arrangement for Philadelphia territory, and have opened up a direct office with W. Y. Shaw as manager, 1337 Real Estate Trust Building, Philadelphia, Pa.

AMONG METAL MINING orders received during May, 1914, the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., reports the following:

August Mining Co., Sandusky, Mont., 3 75-kv.a., 11,000-v., type SK transformers, 1 electrolytic lightning arrester, 1 complete switchboard equipment, 1 125-hp. belted motor for tube mill drive, 1 35-hp. motor for driving rolls, 1 25-hp. motor for driving crusher, 1 15-hp. motor for driving belt conveyor, 1 10-hp. motor for driving air compressor for agitator, 2 7½-hp. motors for driving triplex plunger pump, 1 3-hp. motor for driving placer firer, 4 7½-hp. slow-speed motors for driving slime pumps, complete line material for 23,000-v., high tension line, 2 4-kv.a., Type S lighting transformers; International Smelting & Refining Co., Miami, Ariz., 7 50-hp. back geared a.c. mill motors with magnetic brakes for operating 12-ft. Great Falls type converter, 2 150-hp. motors for belt driving rolls and crushers, 2 25-hp. back

geared d.c. mill motors for Matte casting machines, 10 d.c. motors with brakes and magnetic control,—all of this apparatus for a new copper smelter; Utah Copper Co., Magna, Utah, 7 10-hp. special vertical slow-speed motors, for driving agitators in an installation using oil flotation process; Daly West Mining Co., Park City, Utah, 1 300-hp. 2200-v. hoist motor with liquid controller and complete switchboard equipment; Alaska Gastineau Mining Co., Juneau, Alaska, 1 6-ton storage battery locomotive, 1 50-kw. motor-generator set; Empire Mines & Investment Co., Grass Valley, Cal., one 500-hp. motor for double drum hoist, 1 liquid controller, 3 200-kv.a., 4000-v., O. I. S. C. transformers, 1 3-phase 45-kw., induction motor, 6 35-hp. special back geared stamp mill motors. The control equipment furnished will include all switchboard apparatus and a number of special safety devices.

LAGONDA MFG. CO., of Springfield, Ohio, is building a new addition to its factory to increase the facilities for specialized manufacture. The new addition will be 110 by 60 ft., of brick and concrete construction with a steel supported slate monitor roof. To cover the necessary demand for power, a new 100-hp. gas engine is being installed.

EXTREMES OFTEN ATTRACT attention by reason of unusual size, and in power apparatus, either the largest or smallest of any type of apparatus is of interest.

Cut herewith shows what is believed to be the smallest practical hinge belt fastener yet produced, manufactured by the Flexible Steel Lacing Co., of Chicago, and is a modification of its Alligator design. This fas-

tener is for use on printers' tapes, or other tape belts not over 1/16 in. in thickness, and has been found to give a joint as smooth as that made by hand sewing, yet much stronger. Like all Alligator lacings, it is put on with a hammer as the only tool, making a flexible, lasting joint, with great saving in time.

EXCEPTIONALLY GOOD recent increases in domestic and foreign trade are reported by the Cling-Surface Co., Buffalo, N. Y., showing wide improvement in industrial activities, and the foreign business in belt preservative has spread in different countries so that it now almost equals the domestic. This has necessitated the register of the name "Cling-Surface" and accompanying trade mark in over 30 countries, and carrying large warehouse and agent stocks in more than 50 foreign cities.

THE BROWN INSTRUMENT Co. will occupy its new factory at Wayne & Windrim Aves. within a half block of Wayne Junction Station, Philadelphia, about Oct. 1. The building is 2 stories in height, of the most modern construction, facilitating the manufacturing and calibration of scientific instruments. A power plant will be installed.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price, $1.75 a year.

Foreign Countries, subscription price, $2.50 a year.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 So. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

ADVERTISING RATES

Display

Full page, one year, each insertion, $60.00.
Half page, one year, each insertion, $35.00.
Quarter page, one year, each insertion, $20.00.
Eighth page, one year, each insertion, $12.00.
Front cover, $150.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stipped plates used, but no heavy, black and white plates.

Invoices are rendered monthly and subject to 2 per cent discount within 10 days.

Classified Rates

Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 23,500.

Technical Publishing Co.
537 S. Dearborn Street
Chicago

Position Wanted

POSITION WANTED—By Master Mechanic and Chief Engineer or Chief Engineer of factory or pumping station. Address Box 361, Practical Engineer, Chicago, Ill.

POSITION WANTED—Contracting and consulting engineer's practical steam fitter desires work with a reliable firm. Can furnish skilled work from plans or take charge of job. Sober; work and advancement desired. Only good position considered. Address Box 362, Practical Engineer, Chicago, Ill.

Wanted

WANTED—An old, steam specialty manufacturing concern will consider purchase of an established kindred business. Box 366, Practical Engineer, Chicago, Ill.

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED—Secretary of local Engineers' Association to write at once in regard to a very interesting proposition. Address Practical Engineer, Circulation Department.

WANTED—A small ice-making and refrigerating plant with a daily capacity of about 10 to 15 tons is wanted by a subscriber. A second-hand plant preferred. Give full particulars. Address, Box 341, Practical Engineer. tf.

WANTED—Will buy a patent, recently granted, under which some business has been had. Must be reasonable in price. Preferably along steam specialty lines. Box 364, Practical Engineer, Chicago, Ill.

WANTED—Every local Engineers' Association to have an assortment of valuable power-plant books—Secretary, write at once for full particulars. Address, Dept. C, Practical Engineer, Chicago.

WANTED—A few hustlers to take orders for Zinco Soot Destroyer. Quick Sale. No competition. Good proposition. New York Supply Exchange, Ford Bldg., Detroit, Mich. tf.

Help Wanted

WANTED—An A1 position is open to a good man capable of developing steam specialties and taking charge of manufacturing end of advertisers' business. Box 365, Practical Engineer, Chicago, Ill.

WANTED—To report August 15th to September 1st, a competent engineer to take charge of a 600-kilowatt, direct-current, two-unit, street railway power plant in Northern Illinois. Have cross compound condensing engines, water tube boilers, water softener, etc. Applicants must be of good habits and possess requisite experience and ability for successfuly maintaining and operating above described plant. In first letter state age, experience, salary desired, when can report, and other details. Address Box 358, Practical Engineer. tf.

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once.

WANTED—An additional subscription solicitor wanted to cover towns in the State of Oklahoma. Excellent chance to earn extra money. Write to Subscription Department. tf.

For Sale

AN ENGINE BARGAIN—1 Hewes & Phillips Cross Compound Horizontal Engine, 16⅛-in. and 28-in. by 42-in., 450-hp., at 100 lbs. pressure, 12-ft. by 40-in. flywheel, floor space, 18 ft. by 25 ft. 1 Watts-Campbell, single cylinder, horizontal R. H. Corliss engine, 18-in. by 42-in., 150-hp. at 100 lbs. pressure, 12 ft. by 30 in. flywheel, floor space 10 ft. by 24 ft. 1 Watts-Campbell, single cylinder, horizontal R. H. Corliss engine, 16 in. by 42 in., 125-hp. at 100 lbs. pressure, 12-ft. by 30-in. flywheel, floor space 10 ft. by 24 ft. 1 Wm. Wright, single cylinder, horizontal, old type Corliss engine, 16⅛ in. by 30 in., 75 hp. at 85 lbs. pressure, 12-ft. by 32½ in. flywheel, floor space 18 ft. 10 in. by 6 ft. 8 in., side crank, 4-valve releasing gear. All the above in first class condition. Address Box 360, Practical Engineer. 8-1-5

FOR SALE—A Twentieth Century Steam Indicator, with three-way cock and polished oak case for sale. Only used a few times, and is as good as new; price, $25.00; regular price, $55.00. A great bargain. Engineer, 113 Pearl St., New York.

FOR SALE—550-volt, 60-cycle, 3-phase alternating current motors, complete with starting boxes. 1 50-hp., $310; 1 30-hp., $216. 110-volt, d.c. motors: 1 10-hp., $150; 1 3-hp., $72. All cash, 30 days. Parks & Woolson Machine Co., Springfield, Vermont. 7-15-4

ENGINES—Two 15 by 12 Harrisburg Fleming, side crank engines, $300 each; one 17 by 24 Erie City, 4-valve engine, $700; two 18 by 30 Reynolds Corliss engines, $700 each; one 28 by 48 Hamilton Corliss engine, $1200; one 8 by 12 Buckeye engine, $125; one 8 by 8 New York Safety engine, $100. Duzets & Son, 50 Church St., New York, N. Y.

CARR VENTILATED FURNACE ARCH for all types of boilers and furnaces, gives 100 to 400 per cent greater service than any other kind. Write for information, giving number and kind of boilers and furnaces. Elmert E. Carr, 231 Insurance Exchange Bldg., Chicago, Ill. 7-1-4

FOR SALE—At a Bargain. New 5 by 6, 4-cylinder, governor-controlled engine, fully equipped with carburetor magneto. Will sell for much less than cost. Fred Hanson, 570 Prior Ave., St. Paul, Minn. tf.

Patents and Patent Attorneys

PATENT YOUR INVENTION. Send sketch for free expert search and report as to patentability. Books on inventions and patents, and books of references from congressmen, manufacturers, bankers and inventors sent free. John S. Duffie & Co., 612 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY. Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact cost. Send for full information. tf.

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in NEW subscriptions (not your own) to Practical Engineer. Gilt edges; bound in leather.

Miscellaneous

WE GUARANTEE our device will remove scale, mud, and keep a boiler from foaming without the use of compound; to prove this we will let you try one 30 days without cost. Before buying any machine, write for booklet and compare ours with other makes and see which is best. Lincoln Boiler Cleaner Co., Lincoln, Ill. 7-15-4

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you. tf.

Sparks From The Advertising Pages

An interesting and important side light on advertising was printed recently in *Coal Facts:*

> "It may interest you to know that most publications are supported by the advertising. Many of them could hardly pay for the paper with the money which they obtain from subscriptions. The cost of printing, postage, illustrations, and of editing the paper must come from the advertising. This is true of most magazines, farm publications and large newspapers. Even few local newspapers could exist without the income from their advertising columns. There are over 22,000 publications in the U. S. The high degree of intelligence of the American people is due largely to the abundance of inexpensive and excellent reading matter. While much of it is of no permanent value, *a liberal education along almost any line may be gained by reading the trade or technical papers,* farm papers or the general magazines. It is true that both the development of the telephone and telegraph and the wide and prompt mail service of the railroads have made the gathering of information easy and much cheaper, yet even much of the development of these industries would not have taken place but for the money that advertising has put into the pockets of the publications, which enables them to pay for quick and accurate service."

Advertising is made profitable to the advertiser only through being read by you. And if you read his advertising he indirectly reciprocates by making it possible for you to get 1200 pages of solid editorial reading matter delivered to your power plant for one dollar per year—concretely illustrated in the yearly subscription price of Practical Engineer.

Therefore, when you read the advertising pages of Practical Engineer you are obtaining a liberal education along the line of power plant equipment, you are benefiting your firm by adding to your buying knowledge, and you are making possible the low price at which you purchase this publication.